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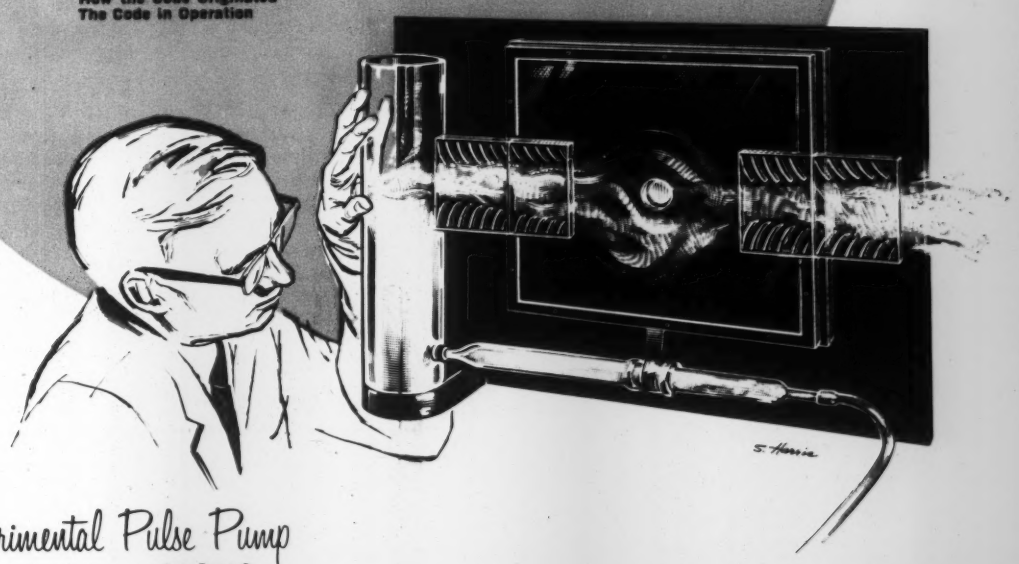

Experimental Pulse Pump

See Page 3

Steam does numerous jobs in the modern hospital, from the important chore of sterilization to the routine task of heating the building.

Steam Supply by B & W

Saves Monmouth Memorial Hospital $10,000 a Year

"Package" Boiler Supplies Clean, Dry Steam for Many Uses

An oil-fired B&W Integral-Furnace Boiler is saving $10,000 a year for the 350-bed Monmouth Memorial Hospital at Long Branch, New Jersey. This boiler heats the hospital, nurses' residence, doctors' office building, and clinic. It supplies steam for the cafeteria, main kitchen, floor pantries, sterilizers, and laundry.

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It Will Pay You to look at your steam costs regardless of your demands, whether large or small, or for process or heating. During the normal life expectancy of many boilers, the fuel bill can amount to several million dollars. Unless it is well engineered, serviced, and maintained, a boiler's efficiency can drop off 2 or 3 per cent or even more. This amounts to a substantial sum of money.

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BOILER DIVISION

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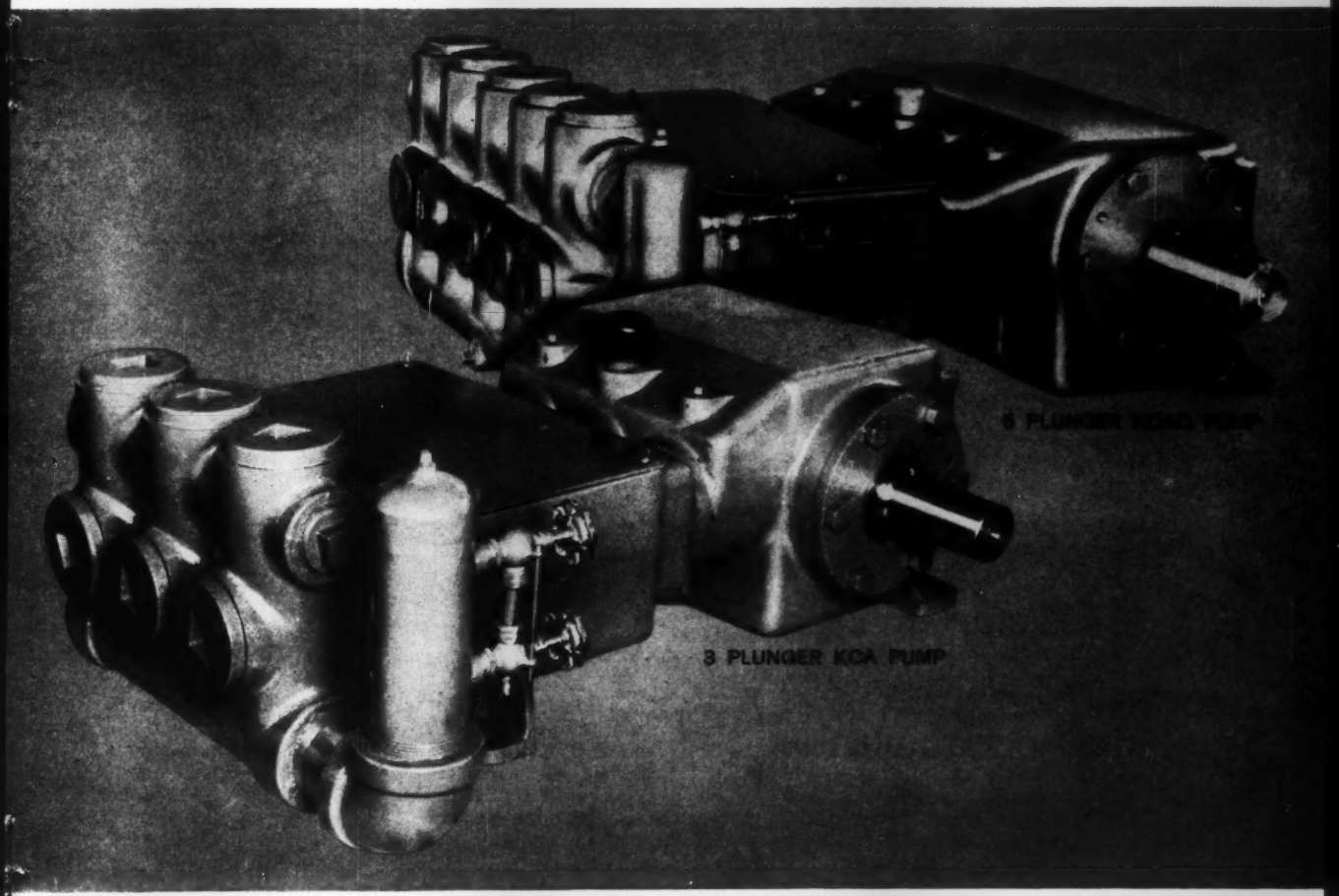


Before you buy a high pressure pump for your hydraulic application, see Worthington's new KCA and KCAQ pumps. You can depend upon these two new pumps to give you highest capacity and most pressure at truly low prices.

These horizontal power pumps save you up to 53% on initial cost. Some of the many applications for the KCA and KCAQ units include hydraulic presses and shears, steel mill roll balance, die casting, boiler feed service, descaling, cleaning and washing, fog spraying, hydrostatic testing, and rifle drilling coolants.

The KCA and KCAQ pumps have 6 outstanding features:

1. Meets wide range of conditions. Plunger diameters can be varied from 1¼ to 2½ inches.

2. Fewer Spares to carry—Wearing parts interchangeable between KCA and KCAQ pumps.

3. Many "extras" included as standard such as solid ceramic or Colmonoy plungers, suction air chamber to minimize noise and pulsation, plunger packing and stuffing box cover.

4. Flooded suction adequate because large pipe connections minimize friction. KCAQ has 4″ suction, 3″ discharge on either side. KCA has 3″ suction, 3″ discharge on either side.

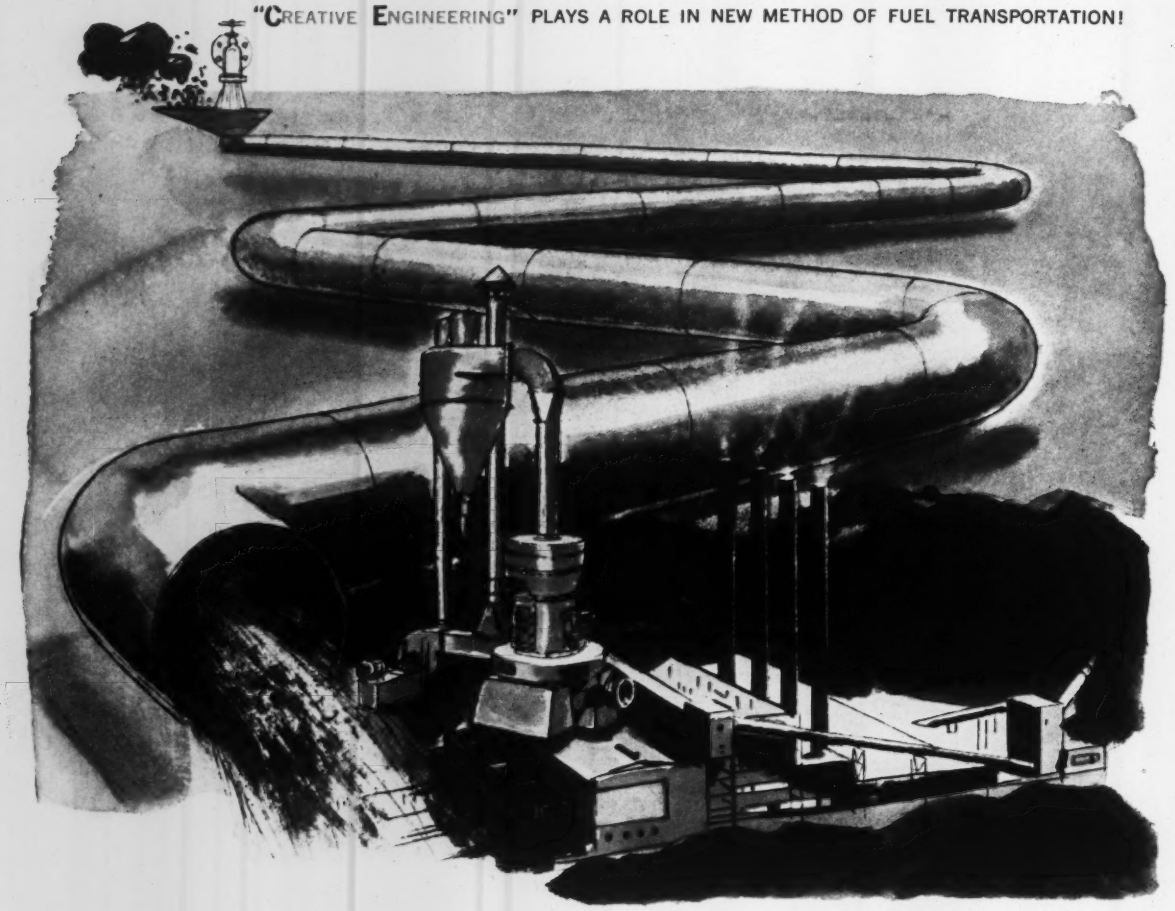
5. Less valve wear resulting from guided, wing-type valves that are self-grinding. Liberally-sized suction and discharge valves both removable through single top covers.

6. No shaft deflection problems. Extra heavy crankshaft has *all* roller bearings.

For complete information, get in touch with your nearby Worthington representative. Or write to Worthington Corporation, Section 32-4, Oil City, Pa. In Canada: Worthington (Canada) Ltd., Brantford, Ont.

WORTHINGTON

"CREATIVE ENGINEERING" PLAYS A ROLE IN NEW METHOD OF FUEL TRANSPORTATION!



History-making pipeline effects new economies in fuel transportation

The first long-distance coal pipeline in the United States went into regular commercial operation last summer and is now moving coal . . . at a rate of more than 1.25 million tons a year . . . from a mine to a utility power station over a hundred miles away. This history-making pipeline runs from the Georgetown properties of Consolidation Coal Company in eastern Ohio to the Eastlake plant of The Cleveland Electric Illuminating Company near Cleveland. The coal is pumped in the form of a "slurry"—a 50-50 mixture of crushed coal and water.

At the Eastlake plant, the slurry is delivered to dehydrating equipment—including a battery of C-E Flash Drying Systems. Moisture is removed at the rate of 36,000 gallons per hour. The dried coal is then pulverized in C-E Raymond Pulverizers and burned in four mammoth C-E Boilers of the Controlled Circulation type . . . together capable of producing over 4,000,000 pounds of steam per hour.

Once again, C-E equipment plays an important part in an industry's technology—helping to bring new economy to power generation.

"CREATIVE ENGINEERING" is the reason for the leadership attained by C-E products. The products which bear this mark of leadership include:

all types of steam generating, fuel burning and related equipment · nuclear power systems · paper mill equipment · pulverizers · flash drying systems · pressure vessels · soil pipe

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MECHANICAL ENGINEERING

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THE COVER

A big IF at Battelle Memorial Institute, Columbus, Ohio: Will a "pulse pump"—plastic model shown—be effective as a mover of gas in systems such as central heating? The diaphragm in the center vibrates at the resonant frequency of the system—120 cps in the model. Intermittent flame may replace the diaphragm. The secret is in the curved vanes which convert alternating motion into one-way motion. System efficiency will depend on development of this one-way valve. With a ratio-of-flow of 8, the Institute will have a successful device. The man is Battelle's Carl F. Speich.

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The Code in Operation.....**E. M. Kloeblen**

You wouldn't remember. Boiler explosions were in every newspaper, like train wrecks. Then, in 1915, came the ASME Boiler Code, for sound construction. The Code's development has never ceased.

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How B&W JOB-MATCHED TUBING simplifies fabrication of hydraulic cylinders

... The complete range of sizes and types of finish plus close tolerances help to simplify fabricating operations.

... Quality control from start to finish in the tube making operations helps to speed up fabrication and to make a better product.

... Controlled heat treatment provides desired properties for ease of fabrication.

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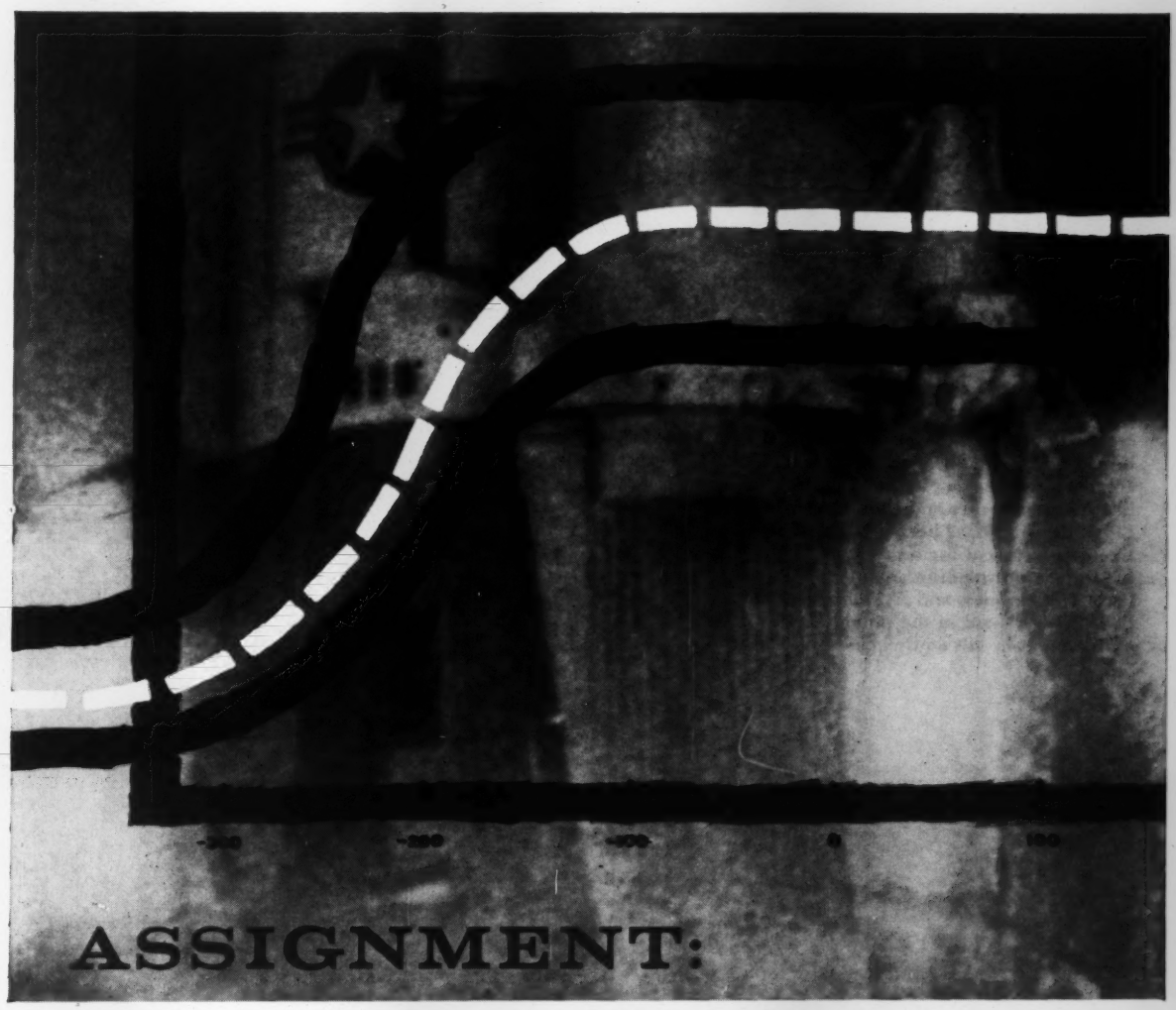

CRYOGENICS

How Lukens *Application Research* helps you find the right steel plate for the job

If your assignment is designing equipment for extreme low temperature service—our Application Engineering staff can help you. They research problems of every description from the design stage right through to how the equipment has performed for years after its installation.

Missile components and liquefied gas tanks would be dangerously susceptible to cracking if made from ordinary steel. Seeking economical metals for such applications, Lukens engineers began years ago to watch the performance of nickel bearing alloys in a variety of low temperature equipment. Result: a broad understanding of metal behavior at various low temperature levels.

Examples: In the storage of liquefied oxygen, a tank of *Nine Nickel steel* provided more than eight years of trouble-free performance. Suitable to minus 320°F. service the steel showed no signs of cracking when removed for inspection. In frigid chambers for testing high altitude aircraft, *2½ percent nickel steel* is standing up well under pressures as high as 7,000,000 pounds. And in arctic locomotives operating at temperatures to minus 50°F. on rugged mountain roadbeds, main structures of *Lukens "T-1" Steel* have required no maintenance whatsoever.

Lukens Application Engineers know these cases . . . plus many more. *If your assignment is cryogenics, why not let it be our assignment, too?* Contact Manager, Application Engineering, G 79 Services Building, Lukens Steel Company, Coatesville, Pa.

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ASK FOR LUKENS NINE NICKEL STEEL BULLETIN

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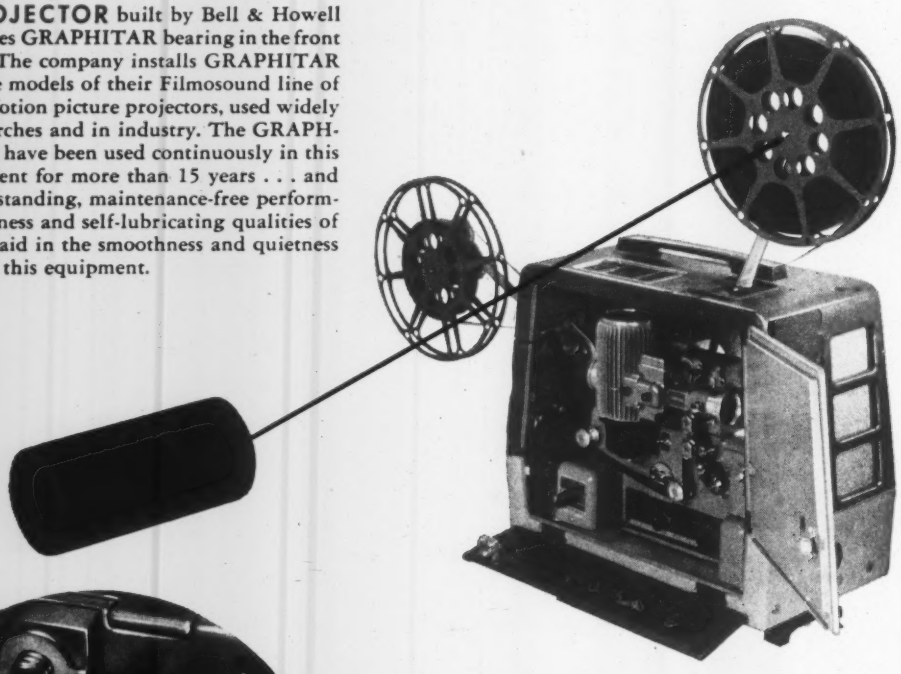
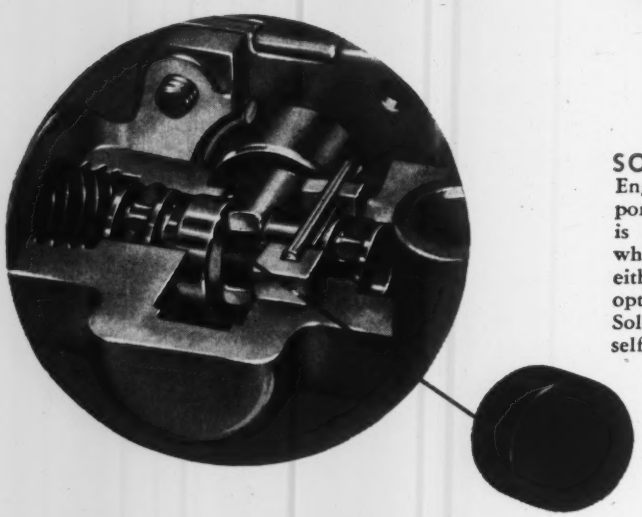
successful in a wide variety of applications

MOVIE PROJECTOR built by Bell & Howell Company utilizes GRAPHITAR bearing in the front reel assembly. The company installs GRAPHITAR bearings in five models of their Filmosound line of 16mm sound motion picture projectors, used widely in schools, churches and in industry. The GRAPHITAR bearings have been used continuously in this line of equipment for more than 15 years . . . and have given outstanding, maintenance-free performance. The hardness and self-lubricating qualities of GRAPHITAR aid in the smoothness and quietness of operation in this equipment.

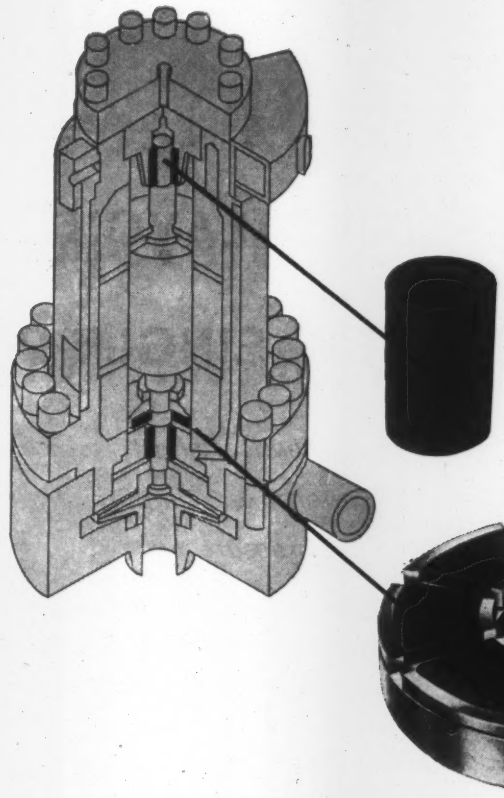




SOLENOID VALVES manufactured by Valcor Engineering Co. for use in guided missiles incorporate a floating seal of GRAPHITAR. This seal is a precise, optically flat GRAPHITAR disc which floats in the plunger. A slight pressure, from either direction, moves the disc against an equally optically flat, stainless steel seat, sealing perfectly. Solenoid valve improves with use due to unique self-lapping action of GRAPHITAR.

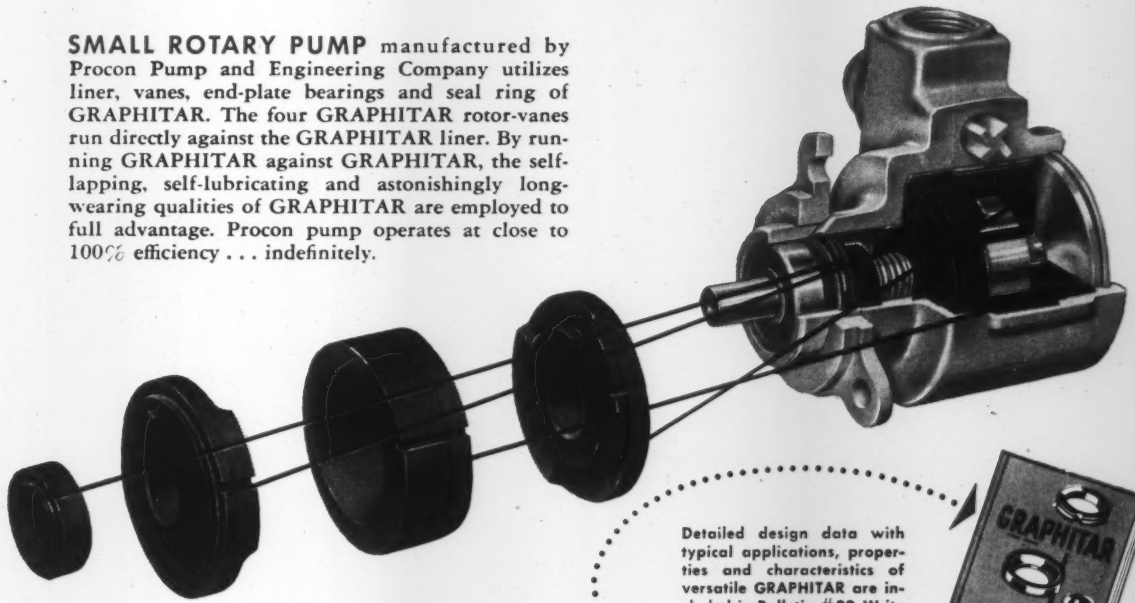
THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



HERMETICALLY SEALED MOTOR-PUMPS have been developed by Westinghouse Electric Corporation to handle radioactive water with zero leakage. The thrust bearings utilized in these pumps are self-equalizing, water-lubricated, pivoted-pad bearings with inserted carbon-graphite (GRAPHITAR) bearing surfaces. The radial sleeve bearings are also made of GRAPHITAR and are designed to be lubricated by the pumped fluid only, in this case, radioactive hot water. These same pumps have proven a convenient means of pumping high temperature fluids for a number of nuclear reactors and other high pressure, high temperature fluid applications.

SMALL ROTARY PUMP manufactured by Procon Pump and Engineering Company utilizes liner, vanes, end-plate bearings and seal ring of GRAPHITAR. The four GRAPHITAR rotor-vanes run directly against the GRAPHITAR liner. By running GRAPHITAR against GRAPHITAR, the self-lapping, self-lubricating and astonishingly long-wearing qualities of GRAPHITAR are employed to full advantage. Procon pump operates at close to 100% efficiency . . . indefinitely.



Detailed design data with typical applications, properties and characteristics of versatile **GRAPHITAR** are included in Bulletin #20. Write for your free copy.

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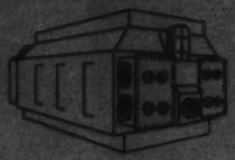
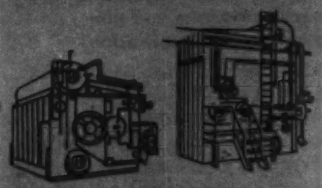
HEAT ENGINEERED BY FW

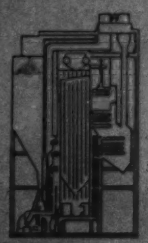


CONDENSERS and HEATERS—Condensers custom designed for individual plant requirements. All-welded high and low pressure feedwater heaters.



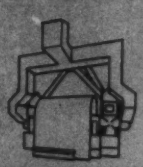
PACKAGED and FIELD-ERECTED BOILERS—Compact, economical, standardized units in capacities from 10,000 to 450,000 lb/hr oil, gas or pulverized coal fired.

LARGE STEAM GENERATORS—Designed to meet all requirements for Central Station or Industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.



COOLING TOWERS—Induced draft counter flow towers of all-redwood construction for maximum dependability and long service.

NUCLEAR COMPONENTS—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.



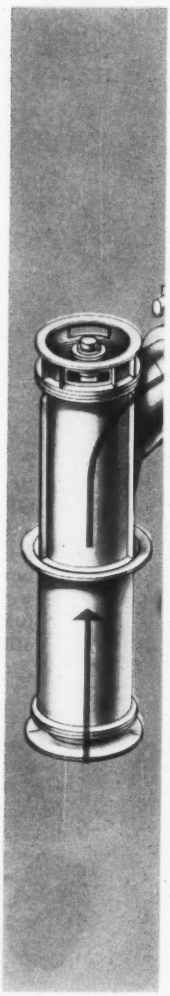
PULVERIZED FUEL SYSTEMS—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

HEAT ENGINEERING

SIMPLIFIES LAYOUT and

WITH NEW SINGLE-PASS,

Compact shells use economical short tubes, eliminate two waterboxes, simplify valving. Balanced back pressure and built-in backwashing system offer further advantages for Alabama Power Company's Barry Steam Plant, Unit No. 3.



Problem: Alabama Power Company and Southern Services, Inc., Engineers, specified that the dual exhausts of the 225,000 kw turbine be handled with condenser tubes at right angles to the turbine shafts —in the tight confines of a plant extension for Barry Steam Plant, Unit No. 3.

Solution: Heat Engineering by Foster Wheeler

By application of the established principles of Foster Wheeler condenser design, a most economical arrangement for a twin bottom-exhaust turbo-generator set with tubes at right angles to the turbine shafts was provided. It features short tube lengths, complete backwashing and a minimum number of waterboxes for a twin-shell design.

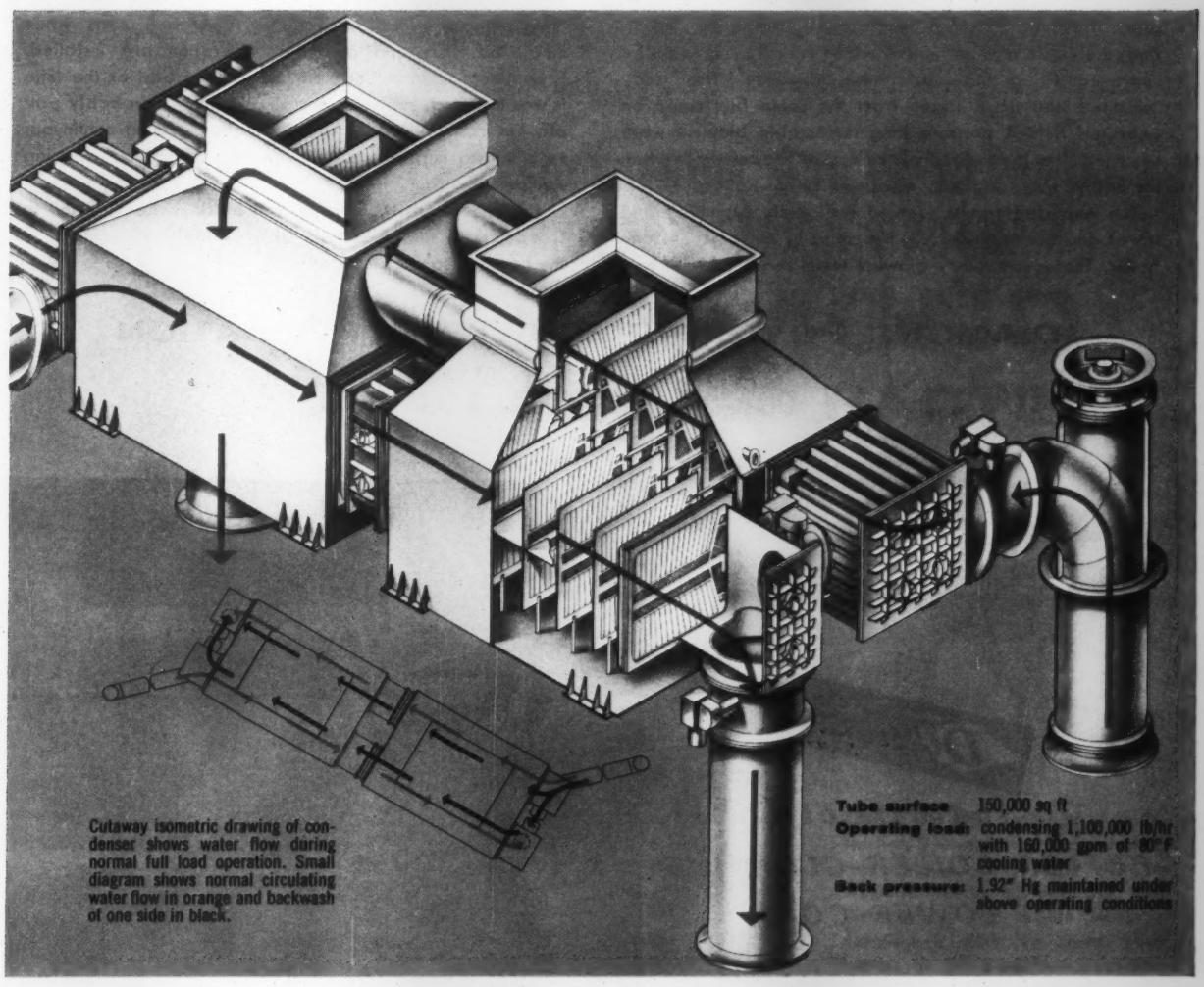
Backwashing of the tube sheets is obtained with only six valves, two of which are the normal circulating pump shut-off valves. This valving arrangement also allows the complete condenser to be operated at light loads with only one circulating pump.

In design advances such as this, you see Heat Engineering at work. This is the concept you can expect—combining new and original ideas with proved engineering principles—when Foster Wheeler serves you. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.*

BY FOSTER WHEELER

REDUCES CONDENSER COSTS

COUNTER-FLOW DESIGN



Cutaway isometric drawing of condenser shows water flow during normal full load operation. Small diagram shows normal circulating water flow in orange and backwash of one side in black.

Tube surface 150,000 sq ft

Operating load: condensing 1,100,000 lb/hr with 160,000 gpm of 80° F cooling water

Back pressure: 1.92" Hg maintained under above operating conditions

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"Increased boiler capacity can often be obtained by modernizing boiler cleaning equipment. Another benefit of such modernization is more efficient utilization of the fuel . . . getting more heat into the steam for useful work and wasting less heat up the stack.

For example, at the Ashland, Kentucky Works of the ARMCO Steel Corporation there are four boilers that were unable to supply the growing steam requirements of the plant. The high exit gas temperatures suggested that a study be made to determine whether the cleaning could be improved to provide additional capacity. This study indicated that more steam from the same fuel could be expected if high pressure long retractable blowers were used for cleaning instead of the rotary blowers with which the boilers were originally equipped.

The expected results seemed sufficiently promising and it was decided to modernize the cleaning equipment of one boiler. The seven rotary blowers were replaced with four Diamond Long Retracting Blowers, one of which is shown below. This modernization proved to be justified as the boiler's maximum steam output was increased 11% and the exit gas temperature was reduced approximately 100° F.

A "Boiler Cleaning Modernization Program" is well worth careful consideration because it can mean substantial savings in so many ways. In addition to increased capacity and more efficient fuel utilization, there is reduced maintenance . . . also reduced operating costs when motorized units and automatic operation are installed. Even though your boiler cleaning was the best at the time it was installed, improvements since then will probably pay off. For many years Diamond has been doing continuous research to improve boiler cleaning and boiler cleaning equipment.

Ask the nearest Diamond office (or write directly to Lancaster) to make a study of your boiler cleaning . . . the possible savings may surprise you."

DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

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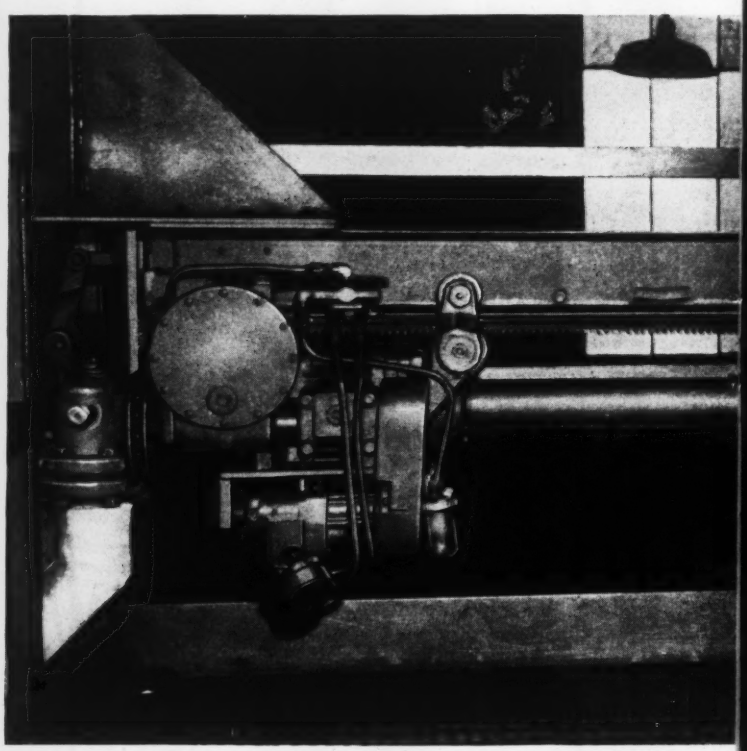


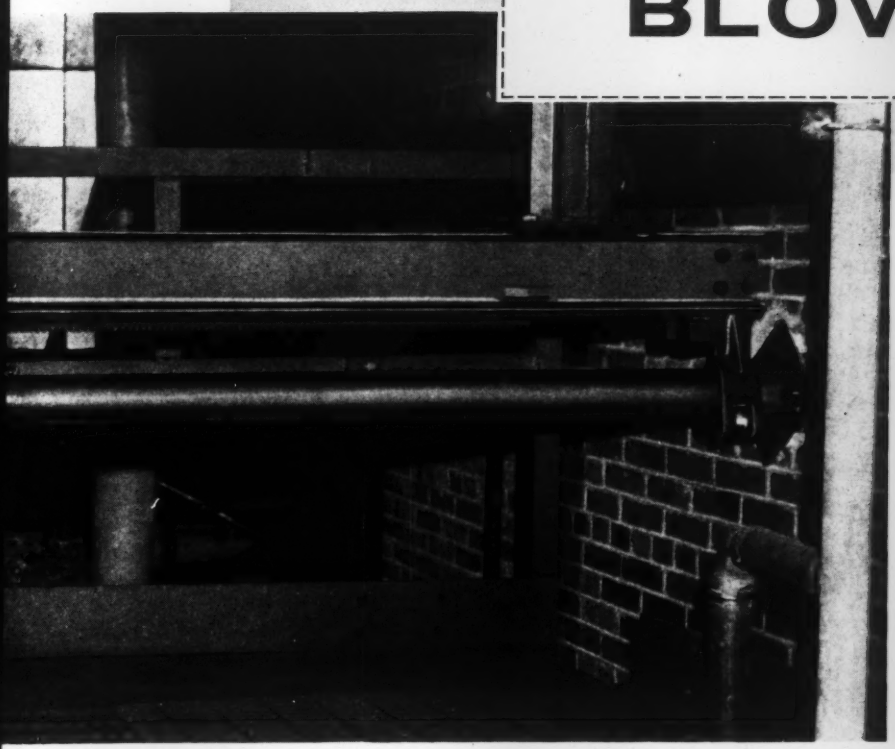
The Mark of

BETTER BOILER CLEANING AT LOWER COST

11% More Steam 100° F Lower Exit Gas Temperature

RESULT FROM BOILER CLEANING MODERNIZATION PROGRAM

Using DIAMOND LONG RETRACTING BLOWERS



One of the four Diamond Long Retracting Blowers used to modernize the cleaning of the first boiler at the Ashland Works of ARMCO Steel Corporation. The results were so satisfactory that the three other boilers in this plant are now also being modernized.

8257

189, 017,

Telegraphic Address
"CITYICE"

Telephone
No. 86879

THE CITY ICE & COLD STORAGE CO.,
12, GENERAL PATTER'S ROAD,
MOUNT ROAD,
MADRAS. 2
INDIA

18 August 1958.

Messrs. United States Hoffman Machinery Corpn,
Air Appliance Division,
103 Fourth Avenue
New York 3, N.Y.

RECEIVED
AUG 25 1958
INDUSTRIAL EQUIPT

Gentlemen: Subject- Hoffman Centrifugal Blower
with motor-direct coupled
Frame No.4008- Type BBA
Serial No.1878-Size BL 20.

We are in receipt of your kind enquiry dated August 5,1958 regarding the working condition of the above blower and motor which were purchased by The City Ice & Cold Storage Co, Madras,2 sometime in 1937. Accordingly we take pleasure to report to you and certify as under:-

1. Ever since the installation in our factory the above blower and motor in 1937, that is for nearly 21 years now, the blower has given us perfect satisfaction without any complaint whatsoever.

2. During this long period of 21 years we never had an occasion to open even a bolt or nut for the purpose of cleaning the machine for for the purpose of looking in for any unsatisfactory working.

3. Beyond greasing the bearings regularly once every three months no further attention was ever needed of us; and no repairs, removal or replacement of any single part has been made.

4. The blower has been working all the 24 hours of the day for 9 months in the year, and for the rest 3 months it works 12 hours a day.

5. The blower and the motor (direct coupled) continues to be in the same original form since its installation in 1937 and we have never come across an efficient and long standing blower similar to this anywhere in the market.

6 Last but not the least, we strongly recommend this blower to ice manufacturers all over the world because it is very efficient, long standing and very economical in use.

Regarding the actual pictures of the unit in operation, we shall be attending to this aspect and send you photo copies in due course.

Thanking you for your kind enquiry,

Yours faithfully,
Hariman K. Irani
(Hariman K.Irani)

047 भार्ड्लस्*

without a single repair and still going strong!

* miles.

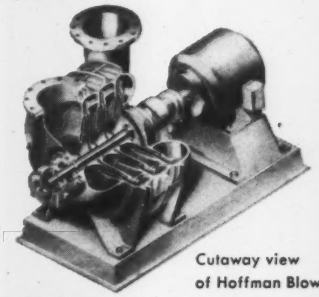
In many manufacturing plants, profit margins are dependent on a number of variables. Perhaps the most significant of these is the cost of materials, labor and *down-time.*

Output up-costs down

Where operating and production schedules depend on the unfailing delivery of clean, dry air or gas at constant pressure, Hoffman Multistage Centrifugal Blowers and Exhausters actually reduce costs, save materials and are free of down-time. For example, the Hoffman Blower pictured here has been in daily use for *22 consecutive years* without the need for repairs of any kind. Despite rugged climatic conditions, it runs its regular schedule of 24 hours a day nine months of the year and 12 hours a day the remaining three months. Over the 22 year period, it is estimated that the unit's impellers have traveled the equivalent of 395 trips to the moon and back, a distance of more than 189,017,047 miles.

Efficiency with economy

Economical operation with Hoffman Million Mile Blowers and Exhausters is assured since power is consumed only in proportion to the actual volume of air or gas handled. The absence of internal wearing surfaces and the lubrication of bearings in outboard mounted housings makes contamination of air or gas impossible. Pressure differential remains constant throughout the range of capacity and air flow is smooth, free of pulsation.



Cutaway view of Hoffman Blower.

Applications

The many production processes for which Hoffman Blowers and Exhausters provide clean, dry air or gas at constant pressure include:

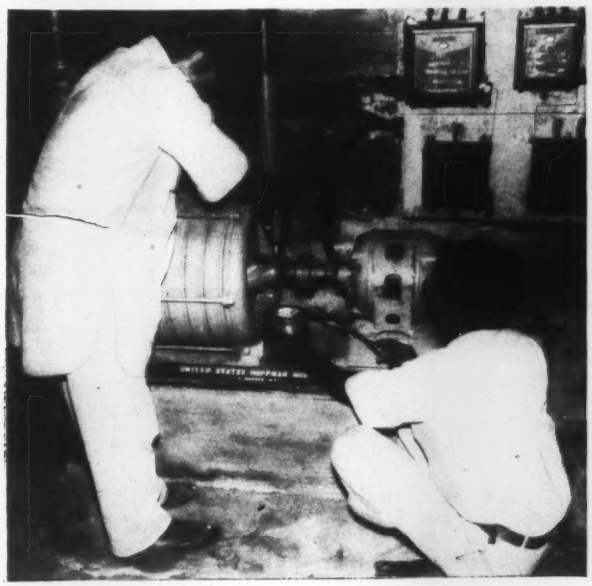
- air squeegee for continuous liquid removal
- vacuum cleaning
- pneumatic conveying
- continuous drying operations
- agitation of plating solutions
- sewage and industrial waste treatment
- ore flotation
- oxidation of oil and asphalt
- combustion
- glass blowing
- raw water ice plants
- production washing of foods
- circulation of liquids
- gas blowers and boosters
- yarn drying
- wrapping, packing and stacking machines
- ejection of stampings from continuous punching machines

Free service

Hoffman Blowers and Exhausters are available in many standard sizes to meet the toughest service demands. Without cost or obligation, Hoffman engineers will provide objective recommendations on units to help reduce costs and boost profits in your plant. Send now for free brochure AB 104.

U.S. Hoffman Machinery Corp.
Air Appliance Division
103 Fourth Avenue
New York, New York

Occasional greasing was only servicing required in 22 years continuous operation.



Weld Specifications

Tension tests are required to be made at room temperatures and at 670° F. The following minimum physical properties shall be met:

At Room Temperature:

TS	YS	EL	RA	CHARPY V-NOTCH
70,000	30,000	45	50	50

At 670° F. the minimum tensile strength shall be 51,000 p.s.i. and the minimum yield strength 18,300 p.s.i.

Rejection

Each casting that develops unacceptable defects during shop working or fails to conform to all of the requirements of these specifications shall be rejected. No repair by welding or other means will be permitted.

Radiographic Inspection

(a) Paragraph S5 (a) of the Supplementary requirements of ASTM-A 362-52T.

(b) All castings shall be radiographed 100% and shall conform to ASTM-E7 1-52, Class 2 quality, except as modified by these specifications.

(c) The manufacturer shall establish a positive system of identification of the X-ray plates which shall be subject to approval by the inspector. This system shall guarantee complete coverage by radiographing and provide for positive identification between the plate and the subject.

Inspection of Penetrants

All castings shall be subjected to inspection by fluorescent penetrants or penetrating dyes both inside and out. All cracks, porosity, or flaws revealed as a result of the Dye Penetrant Test shall be due cause for rejection of the casting.

All cast pipe shall be hydrostatically tested to 5,900 p.s.i. and held at that pressure for 20 minutes with zero pipe leakage. Each length of pipe shall be hydrostatically tested at the manufacturer's plant.

The 304L stainless steel shall conform to the following ladle analysis:

Carbon	.03 max.		
Manganese	1.50% max.		
Phosphorous	.03% max.		
Sulphur	.03% max.		
Silicon	2.00% max.		
Chromium	18.00	-	21.00%
Nickel	8.00	-	11.00%

Pipe: All pipe of the following sizes shall be centrifugally cast stainless steel as per ASTM-A 362-52T, except as modified by these specifications:

16" - Sch. #160
12" - Sch. #160
10" - Sch. #160
8" - Sch. #140

All pipe shall be machine finished to 125 micro-inch interior and exterior.

for nuclear piping met by U.S. PIPE metal mold process

Centrifugally Cast Stainless Steel Solves Many Piping Problems

Combinations of temperatures, pressures and corrosive conditions never encountered before: these are among the piping problems that must be overcome by the men who design the nation's nuclear power installations.

Stainless steel centrifugally cast pipe provides many of the answers. Study the specifications at the left . . . specifications demanded of stainless steel pipe on a recent job for Paul Hardeman, Inc., Los Angeles, California. This pipe is being used for heavy duty, high pressure, elevated temperature service in the primary piping system of the SPERT-III Reactor at the U. S. Atomic Energy Commission's National Reactor Testing Station near Idaho Falls, Idaho. The Stearns-Roger Mfg. Company, Denver, Colorado, is the architect-engineer on this project. A complete tabulation of the actual test data obtained on this pipe and to this specification is available upon request.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses—in large and small quantities—and to individual specifications.

If piping of the type described above is the bottleneck in your nuclear power planning, write and outline the problem.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6" to 50"

Wall Thickness—⅜" and up

Length—Up to 16'

Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E. L. C. grades.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL & TUBES U.S. PIPE DIVISION

BIRMINGHAM, NEW YORK

BOSTON, CHICAGO, CLEVELAND, DALLAS, LOS ANGELES, NEW ORLEANS, PITTSBURGH, SAN FRANCISCO, SEATTLE

How to hang 40 tons of beer from the ceiling

These vessels, called "Dual-Paraboloid" fermentation tanks, are shaped like giant toasters. They're 21 feet long, 13 feet high, and 12½ feet at the widest point. Solar Chicago, Division of U.S. Industries, Inc., makes them from 13-gage Type 304 Stainless Steel sheets that are curved and welded together to form a cornerless interior. 1″ x 4″ ribs are welded around the outside of the tank and all welds are ground to a uniform finish.

Each of the tanks will hold 450 barrels, more than 40 tons, yet the tanks themselves are so light that the entire load will be hung from the ceilings of modern breweries. The formability, weldability and strength of Stainless Steel permitted this unique design. Because the Stainless is so strong, they could use thinner, *lighter* walls.

These tanks weigh 5 tons and they will replace old, square-cornered ones that weighed about *20* tons. Breweries are happy . . . the cornerless, Stainless tanks are easier to keep clean, and because they're off the floor, the plant itself stays cleaner. And because they're Stainless Steel, they will probably never have to be replaced.

USS is a registered trademark

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

Now...you can have Grinnell-Saunders Diaphragm Valves of

Ductile Iron with Glass-Lined Bodies

After long research, Grinnell has available top quality, corrosion-resistant glass lined bodies for its line of rugged ductile iron valves.

EXTRA TOUGHNESS The greater toughness of ductile iron resists impact, torsion, line strains and thermal shock. Grinnell-Saunders valves of ductile iron handle severe service requirements where both internal and external impact shocks may be expected, and where piping stresses from rapid heating and cooling occur.

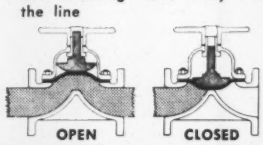
ECONOMY Approved and used by leading industries, ductile iron offers many of the benefits of cast steel at a lower price.

Of particular importance to users of Grinnell-Saunders valves is that ductile iron bodies can now be *glass-lined*—a procedure not practical with cast steel bodies.

WIDE SELECTION Body linings: glass, rubber, neoprene. Diaphragms: soft natural rubber, natural rubber, white synthetic rubber, neoprene, reinforced neoprene, butyl, Hycar, Teflon, Kel-F, PVC (polyvinyl chloride), polyethylene. Bonnet materials: ductile iron, grey iron. Bonnet styles: handwheel (non-indicating stem or indicating stem), chain wheel, lever for quick operation, and sliding stem for a wide selection of power operated topworks.

Important features of the Grinnell-Saunders Diaphragm Valve

- Diaphragm completely isolates operating mechanism from the fluid in the line
- Diaphragm lifts high for full, streamline flow in either direction
- Diaphragm effects positive, leak-tight closure
- Diaphragm easily replaced without removing valve body from the line

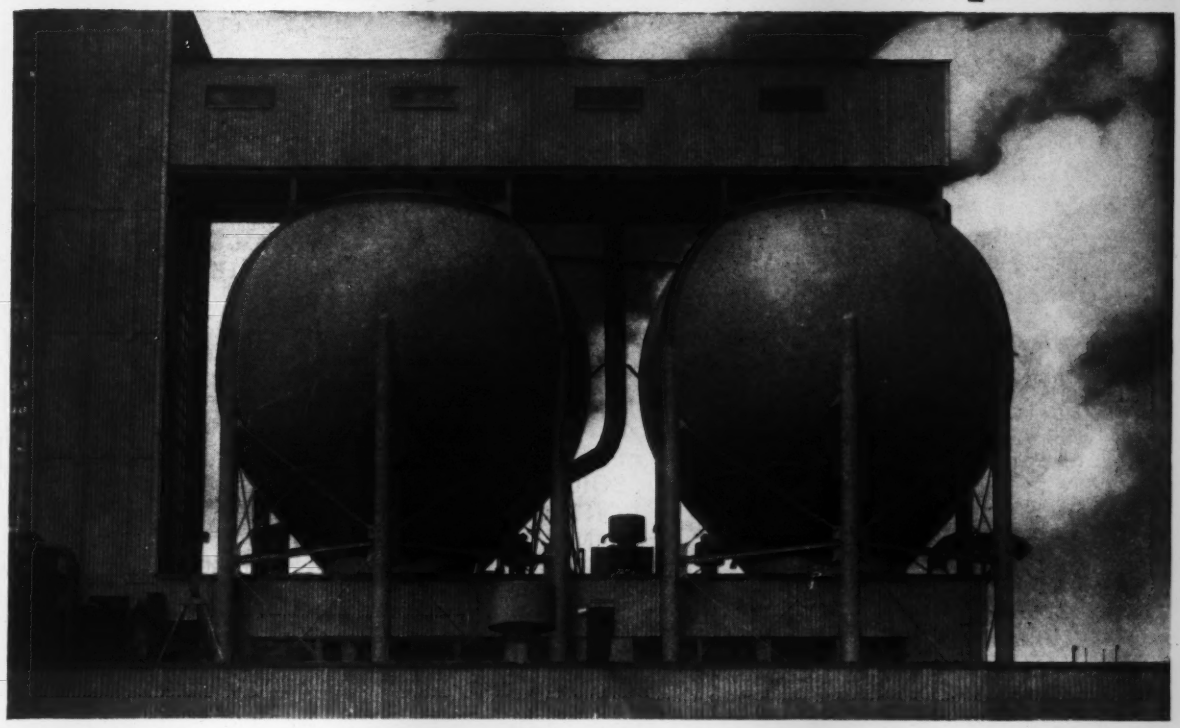


GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

The Case of the Airborne Conispheres:



Why Linde wanted them . . . How CB&I designed and built them

In order to keep a ready and free-flowing supply of calcium carbide available for generation into acetylene, the Linde Company specified that these two 500-ton capacity Conispheres* be installed on the roof of their Montague, Michigan, plant. In order to overcome a specific set of problems it was necessary for CB&I to incorporate special features into their design and construction. Here's how it was done:

Problem: *Insure safe, continuous operation.*

Solution: (1) Structures were designed to meet a specified emergency condition at an increased stress level, as well as to meet normal service conditions at normal stress levels in all parts not governed by explosion conditions. (2) A series of six safety outlets vent tanks upward. (3) Heavy baffle plates were suspended inside the tanks to control flow of carbide.

Problem: *Tanks must support superimposed load of gallery and feed belt equipment.*

Solution: Special framing distributes load to supporting columns of the tanks.

Problem: *Tanks must be mounted on sloping roof.*

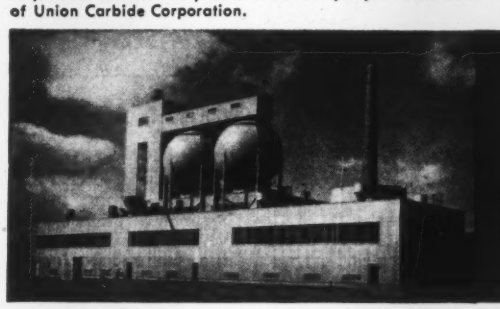
Solution: Three of the supporting columns are longer than others to compensate for roof plane.

Fully coordinated facilities for the design, fabrication and erection of standard or special steel plate structures permits CB&I to work to the most exacting requirements. . . . For this reason industry leaders call on CB&I for the tough jobs and rely on the quality of workmanship that goes into *any* CB&I built structure. A new booklet describes CB&I FIELD SERVICES . . . write our nearest office.

At Montague, Michigan, Linde is one of three major companies combining their talents and mass production facilities to produce DuPont *Neoprene*. Linde Company is a division of Union Carbide Corporation.

*A Conisphere is a Hortonsphere® designed with conical bottom outlet.

E55C

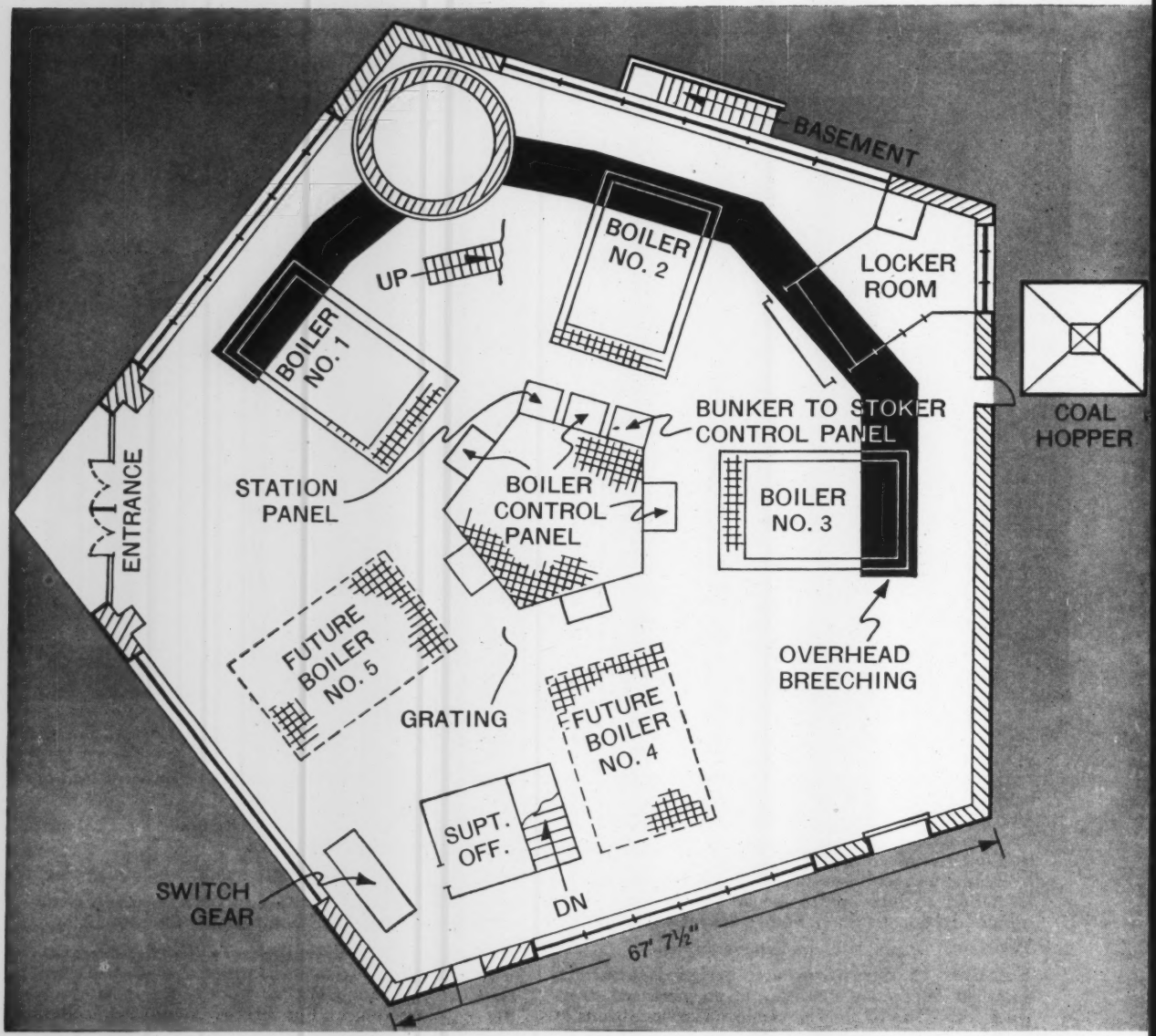


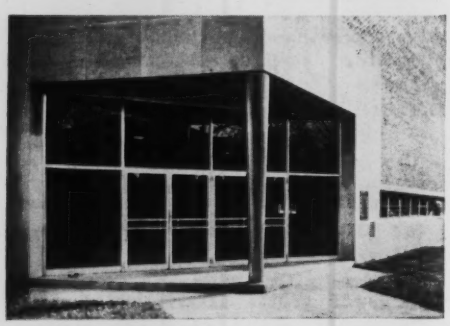
Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa

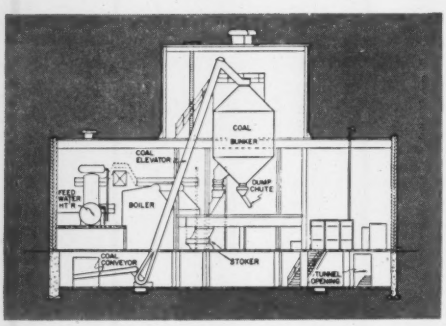
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, GREENVILLE, PA. and NEW CASTLE, DEL.

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland





Entrance to unusual "little Pentagon" structure. This shape gives maximum space utilization and allows one-man central control of all boilers. Construction provides comfortably for three 31,000 lb/hr boilers and allows for two similar units in the future, within 7,000 sq. ft.



Elevation shows how coal moves from incoming conveyor by 25 ton/hr. Stephens-Adamson Redler elevator to overhead bunker (capacity 125 tons). Coal feeds from here to scales, then directly into stokers. Bunker and scales by Beaumont Birch Co.

Coal is brought in by rail and unloaded into track hopper. From here, a Stephens - Adamson conveyor carries the coal into the plant and internal coal handling system.

Hospital cures fuel ills with "little Pentagon"

Richmond State Hospital burns coal for economy and availability in modern pentagonal power plant

After a power system failure at the Richmond State Hospital, Richmond, Ind., the administration conducted an engineering survey of its steam-generating operation. Over-age equipment indicated the need for entirely new facilities. The shape of the boiler room site prompted the unconventional pentagonal installation for best possible adaptation of space to present and future needs. *Economy* and *availability* dictated the choice of coal as the fuel.

Today a new power plant—designed by Fleck, Quebe and Reid, Indianapolis, with F. B. Morse, of Purdue University—burns coal in a completely modern, automatic operation. The outstanding features of this compact installation are its high combustion efficiency, minimum manpower requirements and continuing ease of maintenance.

Coal is lowest cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

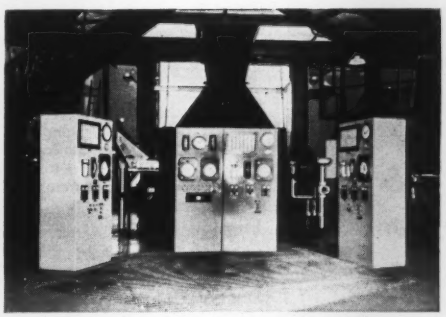
Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

BITUMINOUS COAL INSTITUTE

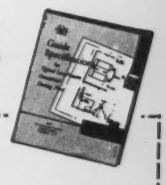
Department ME-07, Southern Building, Washington 5, D. C.

See our listing in *Sweet's*



Shown are three Henry Vogt boilers, fed by Laclede chain grate stokers, with individual control panels. Controls are pneumatic type, by Copes Vulcan. From boilers, ashes are moved pneumatically by United Conveyor Ash handling system to silo for disposal.

SEND COUPON FOR NEW BCI PUBLICATIONS. Guide Specifications, with complete equipment criteria and boiler room plans:



BITUMINOUS COAL INSTITUTE
Southern Building, Washington 5, D. C. ME-07

Gentlemen—please send me:

☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker); ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker); ☐ GS-3 (automatic package boiler for heating and process plants). ☐ Case histories on larger plants.

Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....

CLARAGE

ARCHITECT
Jose Aspe

CONSULTING ENGINEER
Leo Lickerman

DESIGN AND AIR CONDITIONING CALCULATION
Calefaccion y Ventilacion, S.A.

CONTRACTOR
Calefaccion y Ventilacion, S.A.

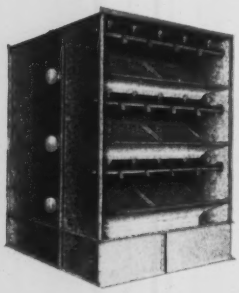
Forward striding Mexico...

another land where Clarage gives air a lift

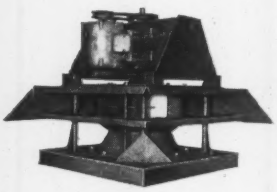
World-wide, Clarage quality is known and called upon. Down Mexico City way, for example, is the new Palacio de Hierro.

Here, in this city's largest and most modern department store, Clarage air handling and conditioning equipment is at work — Capillary Air Washers and Centrilator Power Roof Ventilators. Why is Clarage so often selected for buildings of all types, all sizes? Largely because of this equipment's reputation for faithful performance and operating economy.

Contact our nearest sales engineering office. You too will find it's characteristic of Clarage products to prove out successfully no matter how challenging the requirements.



REQUEST CATALOG 405 covering the Clarage Capillary Air Washer. Equipped with capillary cells. Three arrangements available. Capacities 4,400 to 132,000 CFM.



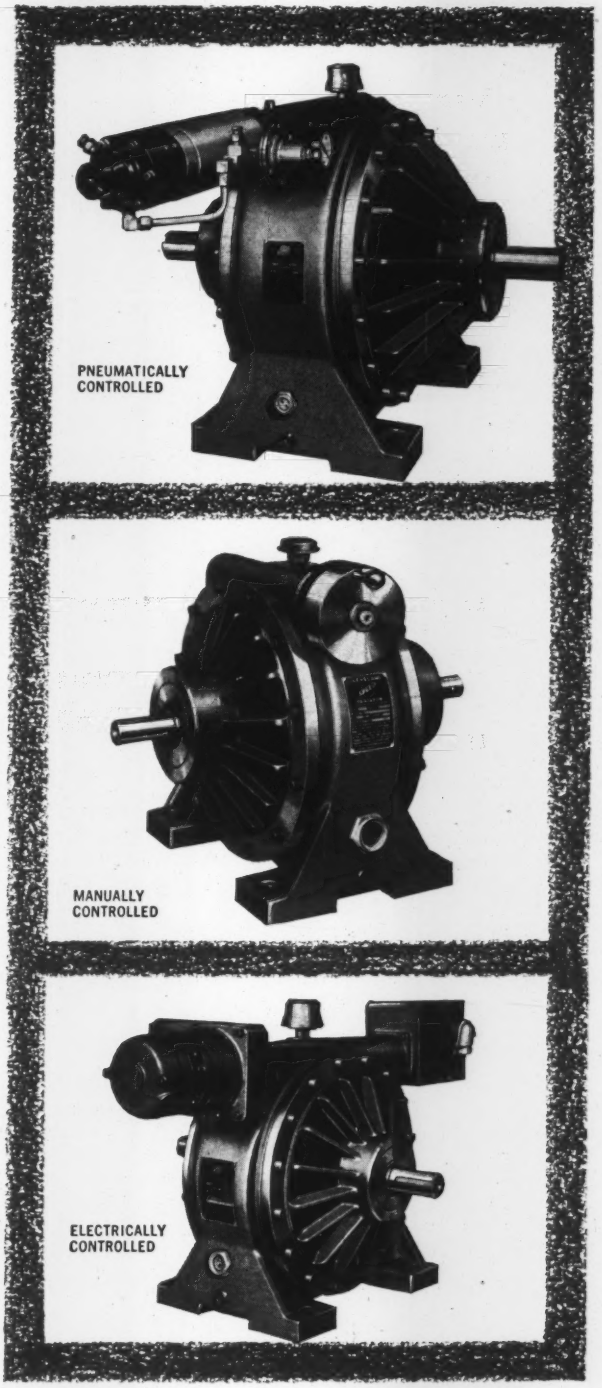
REQUEST BULLETIN 550 covering the Clarage Centrilator Power Roof Ventilator. Static pressures to 2"; capacities to 26,400 CFM. (Unit shown here without cover.)

Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



with Cleveland Speed Variators... precision control is a simple matter

Cleveland Speed Variators — mechanical traction-type variable drives with stepless speed control — provide both increase and decrease of output speed on a range up to 9:1 from a constant speed power source.

Infinitely variable speed regulation is provided with instant, smooth change by either manual, automatic, or remote control. Precise adjustments are easily made with accurate adherence to settings. Some typical examples:

For the Chemical Industry
In rubber processing seventeen variators provide necessary process flexibility when changing production from one type synthetic rubber to another.

For the Automotive Industry
Variators give accurate control of assembly line speeds to control conveyor output rates.

For the Tobacco Industry
Variators make delicate adjustments for electronic beta gage controller.

For the Steel Industry
Variators provide remote control speed change on processing line conveyor.

For the Metal Working Industry
Variators permit fast, accurate adjustment of machining speeds for metals, from magnesium to 38 Rc steel.

For the Wire Products Industry
Variators control four reels simultaneously — and without slippage.

In Ore Processing
Variators easily adjust rate of material feed to hammermill.

In Material Handling
Variators control movement of steel tubes through 176-roll annealing furnace.

The Cleveland Worm & Gear Company
Speed Variator Division
3264 East 80th Street, Cleveland 4, Ohio

A subsidiary of
Eaton Manufacturing Company

Sales representatives in all major industrial markets.

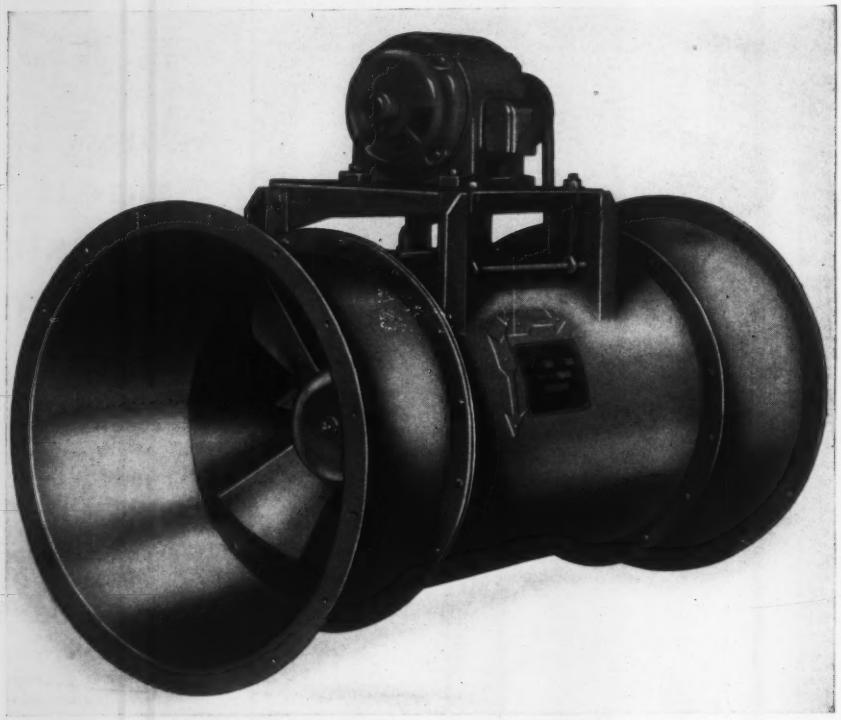
Send for your free copy of Bulletin K-250. It gives the complete Variator control story.

CLEVELAND
VARIATOR

HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).

- **Quiet Running**
- **Easy, Economical Installation**
- **Maintenance-Free Long Life**
- **Compact**
- **Lighter Weight**
- **Ruggedly Built**
- **Wide Range of Capacities**



"Buffalo" Type "B" Vaneaxial Fan

"BUFFALO" AXIALS SIMPLIFY MANY DIFFICULT INSTALLATIONS

"Buffalo" Axial Flow Fans are easily and economically installed because of their rugged, lightweight compactness. In all but the largest sizes, no heavy foundations or structural support are needed. "Buffalo" Axials can be installed as part of the pipe or stack in hood, vat and other roof exhaust systems.

Many ordinarily difficult installations are greatly simplified by mounting "Buffalo" Axials in straight duct runs. Duct-size, they save valuable space.

With "Buffalo" Axials, you are assured a minimum of service calls. Superb engineering and husky construction contribute to long, trouble-free life.

The "Buffalo" reputation for consistent high quality is backed by over 82 years of air-moving experience.

"Buffalo" Axials are quiet and highly efficient in many space-saving installations. These include paint spray booth exhaust, circulation of chilled air for quick-freezing, boiler room cooling, for supply and exhaust in textile plants, and many other uses. Choose from a wide variety of sizes and types to suit the needs of your installations.

Remember, when you specify "Buffalo" Axial Flow Fans, you bring your customers the finest possible performance. Call your "Buffalo" engineering representative, or write for Bulletin 3533-H.

BUFFALO FORGE COMPANY
Buffalo, N. Y.

Buffalo Pumps Division, Buffalo, N.Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

Mn

new specialty Wrought Iron offers better low temperature properties and better impact resistance than many steels

Mn (Manganese) Wrought Iron is a brand new specialty wrought iron offering excellent impact resistance at sub-zero temperatures. To define it: Mn Wrought Iron is a highly deoxidized, low carbon alloy wrought iron containing 1% manganese.

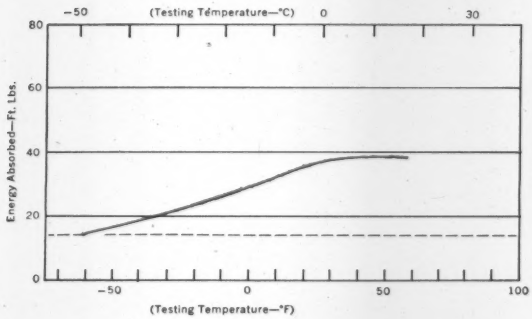
New Mn Wrought Iron is not a substitute for 4-D Wrought Iron. Mn was developed *specifically* to meet critical engineering needs for a tough, yet economical metal in low temperature services where the possibility of brittle failure poses design problems.

Independent impact testing of Charpy V-notch specimens from ½" plate shows that Mn Wrought Iron has a mean energy absorption of 15 foot-pounds at −58°F. Mn Wrought Iron combines this boost in impact strength with the excellent corrosion resistance and mechanical advantages of 4-D Wrought Iron. Mn can be easily welded or flame cut—in field or shop—without requiring pre-heating or post-heating treatment.

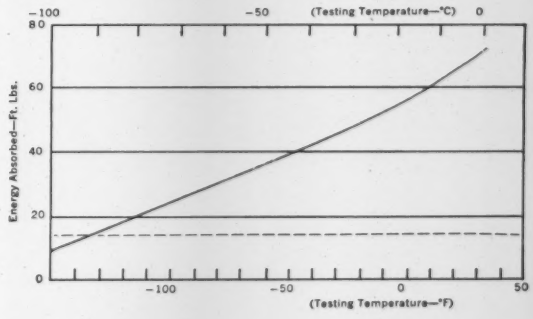
Mn Wrought Iron costs *less* initially than many of the low alloy steels recommended for low temperature service. Available in pipe, plate, and other forms, this new material is well suited for a wide variety of low temperature applications, including such services as tanks and process piping in the refrigeration and petrochemical industries.

Inquiries regarding this specialty wrought iron will receive immediate attention. Write: A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.

Charpy impact values for Charpy V-notch specimens machined from conventionally-produced ½" Mn Wrought Iron plate in as-rolled condition.



Mean energy absorption: 15 ft-lbs at −58°F, notch perpendicular.



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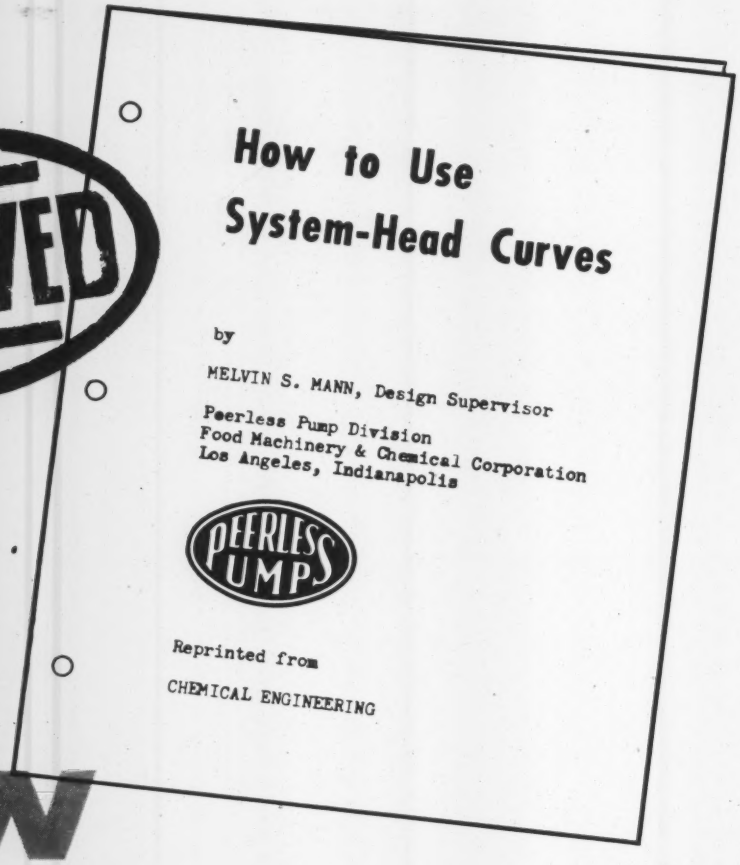

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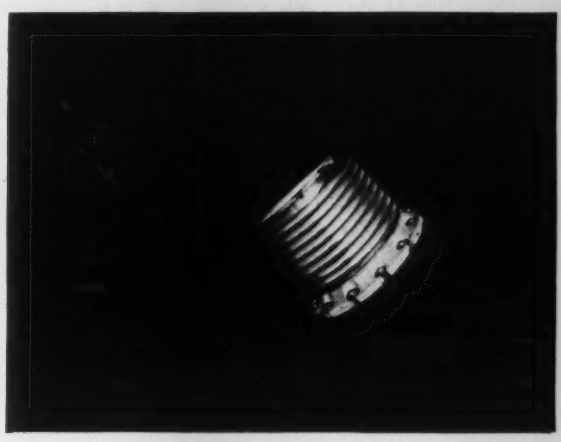
ME

4 WAYS to get maximum reliability in expansion joints

1 Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . . they will always be subject to premature failure because of stress concentrations at the welds.



2 Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.

3 Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.

4 Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

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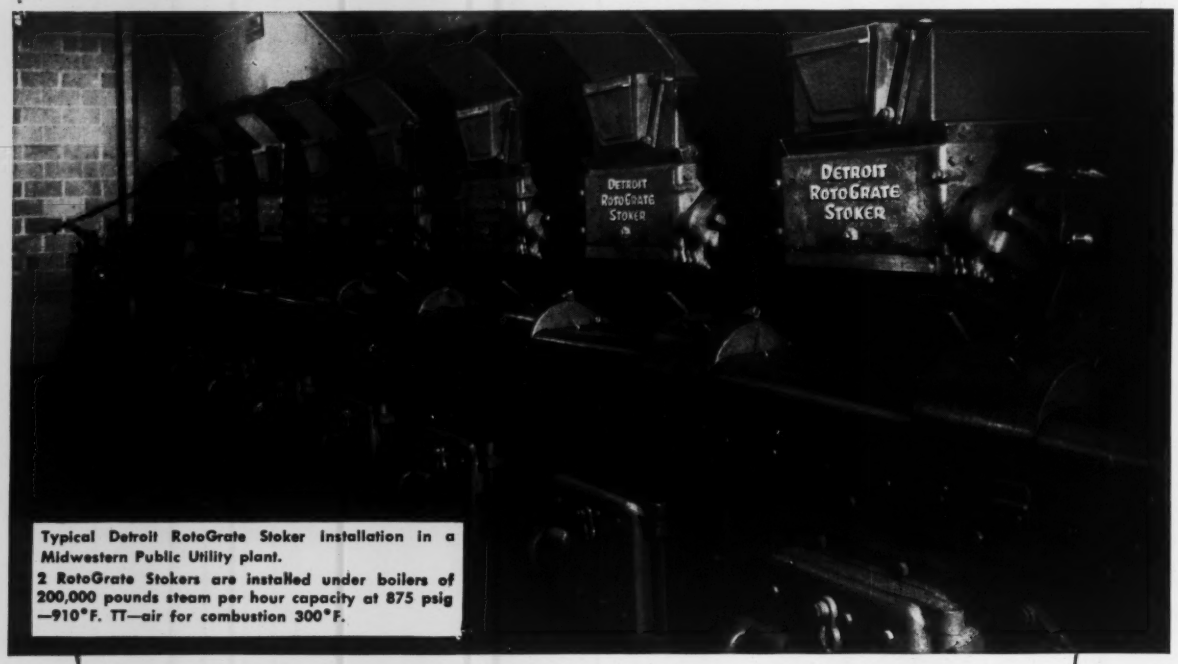

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2 RotoGrate Stokers are installed under boilers of 200,000 pounds steam per hour capacity at 875 psig —910°F. TT—air for combustion 300°F.

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DO BURN all grades of bituminous and lignite coals, and many kinds of waste and refuse fuels . . . Ability to burn the less costly fuels available in any area is a potent factor in economical operation.

DO MAINTAIN uniform high efficiency in everyday operation. RotoGrate doesn't need special test conditions to show superior results.

DO SET a high standard of availability . . . A survey of users shows exceptional availability records in all kinds of plants.

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Through-hardening 4340 Ni-Cr-Mo steel provides the great strength needed in the main drive shaft (a heavy section) to withstand torsional impact loads. The table at right gives details on this steel.

Case-hardened 4615 Ni-Mo steel gives intermediate shafts, differential pinions, spider and side gears the right combination of strength and wear resistance.

The designers also used three other nickel alloy carburizing steels to solve special requirements...4815 (contains 3.5% Nickel) for parts subject to extreme punishment . . . also 4320 and 8620 for less demanding requirements.

If you want to find out more about these steels just let us know. Inco will be glad to show you how to make the most of the general versatility and special properties of the nickel alloy steels.

Average Properties of Type 4340 Steel, 3-inch section, oil quenched, tempered at 1000°

Tensile strength	175,000 psi
Yield strength	155,000 psi
Elongation in 2"	14%
Reduction of area	46%
Hardness	Brinell 370

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MECHANICAL ENGINEERING

VOLUME 81 • NUMBER 7 • JULY, 1959

Engineering Enrollment Drops

"We must point out that it is engineering which is making most of our rapid scientific progress possible. . . .that a moon rocket is a triumph of engineering; the knowledge gained by the rocket's instruments is science." So said one of the 150 deans of engineering polled recently in a survey conducted jointly by the Engineering Manpower Commission of Engineers Joint Council and the American Society for Engineering Education. Reason for the nationwide poll: To find the contributory causes for the drop in freshman engineering enrollment in the Fall of 1958.

For the first time in eight years freshman engineering enrollment declined 11 per cent—from 78,757 in 1957 to 70,029. And, surprisingly, the decline took place in the face of ever-increasing opportunities for highly trained technical manpower and increased over-all college freshmen enrollment.

According to the poll of deans, freshman enrollment was affected by a combination of the following factors:

1 Two thirds of all institutions received a smaller number of applications from qualified students due primarily to (*a*) a false appraisal of the long-range engineering career opportunities by counselors, students, and parents based on reports in the general press on lay-off and reduction of company engineering complements during the 1957–1958 recession period; (*b*) increased concern about the rigors of engineering curriculums; and (*c*) the rush by potential engineering students to other scientific programs.

2 At least one half of all institutions in 1958 accepted for enrollment a lower number of freshmen than in 1957 largely because of the lower number of qualified applicants. However, for 27 per cent of the institutions the use of higher admission standards was a major factor.

3 The proportion of candidates accepted for enrollment that failed to actually enroll in 1958 increased over the previous year in some 4 per cent of all institutions. Half of the institutions blamed the change in "no shows" on higher numbers of multiple applications by students.

In reading over the deans' comments one fact stands out: That the recent publicity given to space and atomic scientists (many of whom are actually engineers) has possibly influenced numerous engineering candidates to study physics or pure science instead.

Another familiar comment also turns up: That industry's eagerness to cut back on engineering employment at the first sign of a business recession has shaken faith in the desirability of engineering as a career.

And in the face of our drop in freshman engineering enrollment it should be of interest to note that in 1958 about 80,000 diplomas, 1000 kandidats, and 120 doctorates were awarded in the USSR. (These figures, by the way, appear in the May, 1959, issue of the *Journal of Engineering Education* in a special report, "ASEE Engineering Education Exchange Mission to the Soviet Union." This report is recommended reading.) During the next seven-year period the USSR plans to increase enrollment in engineering by 90 per cent over the average of the past seven years.

What do our deans of engineering expect for future U. S. freshman engineering enrollment? Forty-five per cent expect increases; 20 per cent declines; and 34 per cent are not able to estimate, or anticipate no change. Which all means that the 1959 Fall freshman engineering class may be slightly larger than in 1958 if at all. Contrasting this U. S. forecast with Russia's plans should give us. . . .something to think about.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

Editor Emeritus, GEORGE A. STETSON

THE TOWNE LECTURE

The Towne Lecture is in honor of Henry Robinson Towne, President of the ASME in 1889, whose paper in 1886 on "The Engineer as an Economist" initiated the flow of valuable Society contributions on scientific management.

By Walter E. Boveri

Chairman of the Board,

Brown Boveri Company Ltd.,

Baden, Switzerland

man's conflict

TECHNICAL progress, as a decisive factor in human society, is of comparatively recent origin and, except for the last decade or two, has been confined almost exclusively to the white race of the Western world. Previous to this period, hundreds of years in the history of Western civilization had passed without showing any appreciable advancement in the science of engineering.

Beginning with the enlightenment of the 18th and 19th centuries, just previous to and particularly during the French Revolution, the foundations of natural science suddenly started to develop to a point at which technical progress received its first real impulse. Searching for the roots of events, we discover that much more significant than the advancement of science is the fact that, as a result of the French Revolution and the declaration of the rights of man, the emphasis was shifted from the collectivity to the individual.

Based on the Towne Lecture presented at the Management Luncheon of the Annual Meeting, New York, N. Y., Nov. 30–Dec. 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The Individual Emerges

For the first time for many a century the value of the individual was not only recognized but its expressions estimated and encouraged. Freedom of speech and of the press, freedom to choose one's religious creed, the right to settle according to one's own choice and to follow one's desired profession, all have combined to remove fetters which might hinder the development of the individual human mind.

Technical progress must be considered as an additional means to further this end, because the improvements in man's way of living, obtained as result of the perfection of technical devices, removed obstacles standing in the way of the expansion of human freedom. With the coming of the railroad, man's radius of action was suddenly greatly increased. Similarly, previous to the invention of the printing press and the much later development of modern book printing, it was almost impossible for the average man to become acquainted with the learning others had acquired. As a result of these inventions, man's mental radius vastly expanded, adding greatly to his freedom of action.

Looking back at the beginning of our age of technical progress, we are able to discern the three components which must combine to make up the general progress of our society. These are: freedom, progress of man's personality and mind, and technical progress.

If one of these three components is lacking, progress of society is halted. Though it is mainly the third component, "technical or scientific progress," which concerns us here, we must nevertheless look at the other two, seeing how closely related and in many ways interconnected they are.

When we speak of freedom, we think of political, possibly economic, freedom and understand by it the absence of obstacles which might interfere with our actions. These obstacles can be represented by men or by matter. However, in both cases they attack us from without, and act against our person. Yet there is another kind of freedom which has its source within man's personality. Known to us as the problem of free will, it has occupied the minds of philosophers from the time of Plato and Aristotle to our day.

The Free Will

This problem of free will is concerned with the question whether man is tied to the confines of the interdependence of cause and effect determining the course of his actions, or whether he is capable of progressing into a mental state in which he is free to decide the path he wishes to follow by the exclusive exercise of his reason. There he reaches the realm in which real creative action, whether it be in science, engineering, or art can be encountered. It is the field where beauty and kindness

Can technical progress be regarded entirely as a blessing to mankind? Or does it contain within itself properties endangering the foundations of our society? In this Towne Lecture of 1958, Dr. Boveri calls for action, that succeeding generations may have the mental and moral disciplines to guard freedom, the freedom that made technical progress possible.

with technical progress

can be enjoyed and where an ethical pattern of behavior may be thought out and carried into action.

To come nearer to this goal, and to be able to exercise full freedom of the will, would constitute real progress of man's personality and mind. This factor, as stated before, is closely connected to our first factor, "freedom." It requires an atmosphere of freedom from without in order to educate oneself to freedom from within, which is the equivalent of our second component, "the progress of man's personality and mind."

Technical and scientific progress, our third component, has been one of the most important contributors in extending the range within which man can exercise freedom. Despite the fact that inequality of opportunity still persists in the Western world, the standard of living of the entire population has been raised to an extraordinary degree since feudal times as a result of technical progress.

Lack of food, of clothing, and of adequate lodging has practically disappeared from Western society. Medical care is universally accessible, and a fair amount of entertainment is available to almost everyone. What a difference this is to the olden days, when a few feudal lords were in possession of all the wealth and the power, while the suffering anonymous masses left no trace of their existence. We may say that technical progress has decisively contributed to free a considerable proportion of man's available energies previously concentrated on providing the barest necessities of existence.

In the United States, the standard of living has attained a remarkable level, rivaled by no other country. With scientific thoroughness production has been increased. Cost prices have been reduced to bring the end products within the buying range of the largest possible section of the population. Services can be rendered today which people in former times would not have dared to dream of. We have even reached the point where new products carry in their wake a new demand, which did not hitherto exist and which had first to be created in order to be satisfied.

A Creeping Suspicion

But here or there a spectator of this triumphal march of prosperity and technical progress is seized with a creeping suspicion that what outwardly appears to be of such benefit to man may eventually lead to the destruction of some of his most precious qualities. He may feel that the freedom man set out to gain by the conquest of matter becomes more and more an illusion, because each further step he takes seems to lead him irrevocably, and contrary to his intentions, into deeper servitude to his new masters—technical progress and materialistic prosperity.

Is it not becoming apparent that real progress of society cannot be measured merely by the number of automobiles, television sets, and washing machines that the community has at its disposal, since these contribute very little to the development of man's personality? Does it not, for instance, seem astonishing how completely dependent our present generation has become on the use of a motorcar? Today, life without an automobile would seem almost intolerable, making us feel quite helpless. Another example is to be found in the way the healthy faculty of natural adaptability of some people has been so diminished by technical progress that they suffer if the temperature in a room in summer reaches the level to which they demand that it must be artificially raised in winter.

Probably the most harmful effect of modern technical inventions on man's mental faculties has, however, been caused by the invention of radio and television, by means of which information, knowledge, and in general all the impressions from the outside world pass through his mind in rapid sequence without requiring the slightest mental effort on his part. By occupying his ear and eye

man's conflict

during his leisure hours, no time is left for the exercise of creative thought and the development of his own imagination. The result is that boredom overtakes man when these artificial stimulants loosen their grip.

A Child Needs Personal Adventure

A slow degeneration of the most noble qualities of the human mind must be the consequence among the grown-ups. However, the effect on children who are deprived of the excitement of exploration and adventure, which consists in discovering the world surrounding them by their own mental effort, will be far worse. The freedom which technical progress and an easier life ought to have provided for them in order to develop more efficiently their bodily and particularly mental qualities has been turned into the very opposite force

How, under these circumstances, can creative thought and imagination, the highest qualities of the human brain, which mature only by effort and exertion, find their way to growth and developments? Even the language, this carrier of subtle thoughts, is continually simplified because it is believed that this might further technical efficiency. How, in all this noise and hustle, daily increased by new technical devices, shall man find the hours of solitude which are so essential to the growth of his mental powers?

At a time when we did not yet know about the fearful weapons which were to fall into our laps by the advancement of technical science, and when people had no need yet to worry what the future might have in store, one of the few men endowed with vision and great insight into human nature gave expression to his apprehensions concerning the future of our civilization. I am thinking of Alexis Carrel and of his book, "Man the Unknown." Among his numerous profound reflections he drew attention to the fact that, while sciences concerned with inert matter have made immense progress, those of the living being remain in a rudimentary state.

Carrel found by careful study that man has been incapable of organizing the world for himself because he does not possess a practical knowledge of his own nature. His conclusion was that we are on a road leading to moral and mental degeneration and that the groups and nations in which industrial civilization has attained its highest development are precisely those which are most rapidly weakening.

Science Creates an Unbalance

It is, indeed, the fabulous advance of the sciences of inanimate matter over those of living things and their expressions and reactions which have led to a dangerous unbalance in our lives. This lack of balance is caused not only by our ever-present desire to create new technical devices to make life easier and add luxuries to it. Far more so, our intellect will always be attracted by the lure of logical reasoning and the beauty of simple mathematical formulas which are only found in the inanimate world. On the other hand, living matter refuses to follow simple rules or clear mathematical formulas. As the imagination and intuition of scientists cannot, and should not, be restricted, there is no limit to where materialistic science can lead us. What we should learn, however, is that the final purpose of all research should never be technical progress but exclusively and always the progress of man.

Technical progress is by no means identical with the progress of man. In our technical age, contrary to all belief and appearance, it is the machines which have progressed but not man himself. Since we erroneously insist on regarding this perfection of inanimate matter as the real aim of society, a stupendous race has set in to invent ever-new devices while distributing those already in existence over still wider areas by mass production. Nothing seems to be more desirable, and no efforts are being spared to achieve this ever-increasing pace of technical advance.

Gradually it has come to pass that technical progress is no longer the servant of man. On the contrary, man, by devoting his foremost energies to this one purpose, has unconsciously become the servant of technical progress. This in turn has compelled him to adapt his whole system of education to the necessities of rapid technical development. There is no time left to form man according to what is most valuable in human nature, nor to let him acquire a part of the learning and the art compiled over the centuries which has formed the essence of Western culture. Ever-increasing scientific requirements, called for by advanced technical progress, make it imperative that from a very early age he should be trained as a specialist, so as to become capable of functioning as a small cog in the soulless machinery of technical progress.

The New Generation—Walking Computers

In the same way as we have learned to build electronic brains fulfilling more rapidly and accurately some of man's mental functions, so we aim at forming some of the members of our new generation into machines strangely resembling these mechanical devices and capable of sorting and combining all information which has previously been pushed into their brains by years of teaching and study. Man, instead of being trained to become as perfect a human being as possible, must be made fit for a job. Life thus already resembles existence in an anthill.

With the advent of the atomic bomb, the dreadful methods of destruction have entered the race of technical progress. Man has really become the slave of technical progress. A concentrated effort on one side, having achieved a faster plane, an intercontinental missile, or an earth satellite, immediately calls for an even greater concentrated effort on the other side to accomplish the same or even better. A fantastic witch's cauldron is being stirred in our technical and scientific world.

But suddenly, not by his own volition but certainly by his own doing, Western man finds himself confronted with the same problem as Hamlet's—to be or not to be:

Whether 'tis nobler in the mind to suffer
The slings and arrows of outrageous fortune,
Or to take arms against a sea of troubles,
And by opposing end them.

Some British philosophers and intellectuals, like Bertrand Russell or Philip Toynbee, seem to have chosen the first course of action. They evidently go so far as to believe that they must act as tools of divine providence in the question as to whether humanity should survive or be exterminated. It may be hoped in their interest that, when they eventually reach the stage of submission of

with technical progress

their country to Russia advocated by them, China, with its 600 million inhabitants, having meanwhile become a dominating political force, will not set out to wage nuclear war on Russia and all its satellites, then including Great Britain.

"Arms Against a Sea of Troubles"

In this country and in my own—as well as in western Europe in general—the spirit of self-preservation, as well as the pride in our form of living, is still sufficiently alive for us wholeheartedly to choose Hamlet's second alternative. But, apart from taking up arms to defend our way of life, we must clearly comprehend the various factors and conditions which have brought about the civilization of the Western world and its consequent political strength.

We must, above all, spare no effort to secure these factors and conditions so firmly as to prevent them from falling into decay. Furthermore, we must proclaim these factors and conditions so that they may carry with them sufficient conviction even to attract other nations with other political creeds.

Technical progress has always been an attraction for other countries. For our own sake, this coveted technical progress should not, however, so completely dominate man's worldy aims as to submerge those finer mental qualities which ought to find their expression in a deepening of man's intellect and sensitiveness, in his longing for the arts, and in an ethical pattern of behavior.

In the days of our fathers and grandfathers the pioneering spirit was still fully alive. Men endowed not only with sufficient knowledge but even more so with great strength of character, endurance, and daring, and above all with boundless imagination, turned this country from a land of prairies into the industrial State with its high standard of living that we see today. Our present generation, overwhelmed by the stupendous technical advance and spoiled and softened by the luxuries this advance carries in its train, is beginning to forget the qualities of toughness and courage which our forefathers possessed to be able to create the world we live in today. These qualities, which we erroneously claim still to possess, have to be regained if we wish to preserve our cultural level and our political influence and to resist all dictatorial forms of Government. If our present generation has not found the strength to restore those qualities for their own good, with a supreme effort they can accomplish it for the next. Youth is formed by an educational system which, while raising it, is outside youth's own influence.

More Than Technical Progress

There is no reason why the splendid American youth of today should not, with proper training, avoid the mistakes which our present generation is unconsciously making, and escape the shallowness of mind which so easily follows in the train of some of the most outstanding achievements of technical progress. The only problem is to arrive at as clear a conception as possible of what is essential for man's development and how to give it effect.

Undoubtedly technical advance, where it is required to protect us from prospective aggressors, must continue until a sincere effort for disarmament comes into evidence. Side by side with it must come the development of the purely human qualities of man, aimed at creating a higher form of individual being. This alone, and not technical development, can render our liberal system distinctly superior to any collective system of government, as practiced over large parts of the world today, whereby the individual is degraded into a serviceable tool for the purposes of the all-powerful State.

To improve the development of man's personality, the teachings of such profound and far-sighted thinkers as Alexis Carrel and several others should not only be read, but should be followed as far as possible by action. In every industrialized country where free enterprise is still upheld, it would be wise for the government to call into being a small body of broad-minded and highly educated men vested with great executive authority in the field of education. These men, having carefully studied past sources of Western culture, should then be empowered to make such alterations at all levels of our system of schooling as to insure that the general mental development of the student is not lost sight of, while at the same time any specialized training can be carried on alongside. In every university a center should be created to uphold the same ideal.

We must, in addition, realize that ingenuity and imagination, those noble qualities of man's mind, can be developed only by strenuous mental training and exercise, sometimes even by hardship; and that intellectual versatility is exclusively obtained by strict discipline of the brain, by endurance, and by deep independent thought not only on specialized subjects but on all the great riddles enveloping our life. However, if man were exclusively to expand his intellectual possibilities in the manner described, he might still resemble only a complicated but soulless device unless he were also to be taught to open his heart to beautiful things and to kindness.

More Than Materialistic Life

Finally, man must learn to realize that, surrounding our materialistic everyday life, there lies a metaphysical sphere which he should try to seek through the arts, philosophy, and religion. There he will discover that the deeper meaning of life can consist neither in technical achievements nor in the furtherance of purely materialistic aims.

All this, however, can come within our reach only in an atmosphere of freedom. Freedom is not merely a constitutional right. It must be learned and reconquered daily in order not to be wasted in the routine of everyday life. The question must further be asked, "Freedom, for what?" because freedom can justify itself only by a just and useful purpose.

Freedom, combined with risk and effort and governed by moral principles, is the source of great achievement. These achievements, grown in the soil of freedom, will always grant us superiority over any communistic system. It is the task of our present generation to make a supreme effort to insure that the generation succeeding us is provided with the right knowledge of freedom and a training in mental discipline and endurance, all based on sound ethical principles. We shall then during our lifetime not only have served technical progress, but we will also have laid a new foundation stone for the progress of man.

NUCLEAR

By Wallace A. Moser, Research Engineer,
Rocketdyne Division, North American Aviation, Inc.,
Canoga Park, Calif.

Because of the weight of the reactor, a nuclear rocket engine necessarily has a higher specific weight than a chemical rocket engine. On the other hand, because propellants of lower molecular weight can be used, the available performance is much higher. The specific impulse of a nuclear rocket ranges from 600 to 1200 sec, depending upon the propellant, chamber pressure, and reactor temperature [1].[1] Without further specification, an optimistic value of 900 sec will be assigned to the specific impulse of a nuclear-heated engine and a value of 400 sec to chemically fueled engines of the same stage of advancement.

If propellant usage is integrated along the flight trajectory of a rocket vehicle, the mass ratio thus calculated can be correlated with a fictitious velocity according to the relation

$$V = Ig_0 \ln R$$

which gives the velocity change of a rocket fired in field-free space. This is a measure of the work which the vehicle must do. For each fraction of propellant used, the nuclear rocket will attain more than twice the velocity increment attained by a chemical engine. However, the mission velocity increases slightly with specific impulse, so that systems of higher impulse appear to pay an energy penalty. For example, the trajectory computation for an ion rocket, which has very high impulses in the range of 8000 to 16,000 sec, indicates that the mission velocity for escaping from an earth orbit and transferring to a Mars orbit around the Sun is more than 90,000 fps, while a quick calculation of this quantity, based on energy change, gives a value of 45,000 fps for a chemical rocket [2]. The theoretical explanation is that this penalty results from imparting more gravitational energy to the propellant before it is exhausted through the engine [3]. High-performance systems more than compensate for this penalty by reduction of the mass ratio, so that the total weight required for taking off with a given payload is significantly reduced. The difference between the nuclear rocket and the chemical rocket probably does not exceed 2000 fps for similar missions which do not escape from the earth.

[1] Numbers in brackets designate References at end of paper.

Contributed by the Aviation Division and presented at the Aviation Conference, Los Angeles, Calif., March 9–12, 1959, of The American Society of Mechanical Engineers. Condensed from Paper No. 59—Av-24.

Reactor Power

The power which the reactor must generate is given by the relation

$$P = \frac{1}{2} FIg_0 \approx 20 \text{ kw per lb of thrust}$$

An engine developing a sizable amount of thrust must develop a large amount of power. The total amount of power which must be delivered to the payload is about the same, whether generated by nuclear fission or the burning of exotic, high-energy propellants. The reactor, however, can generate a tremendous amount of power (total energy) in a compact package. For applications such as boosting a small payload vehicle from the Earth's surface, a small nuclear rocket does not compare favorably with the chemical rocket, principally because of the higher engine weight required by the amount of fissionable material necessary to achieve criticality—from 500 to 4000 lb [4]. However, as the thrust and power requirements increase into the range of practical reactor design, then the lower mass ratio required for the nuclear-powered mission begins to show definite advantages in take-off weight and thrust.

A hypothetical example will serve to illustrate the difference. Consider a one-stage chemical rocket and a nuclear rocket which are each to carry a payload M through a velocity change of 20,000 fps. For the chemical rocket, the indicated mass ratio is 4.73, and for the nuclear, 1.42. Let the unfueled chemical rocket consist of 70 per cent payload, and 30 per cent tanks, engine, and structure. Furthermore, let the unfueled nuclear rocket consist of 40 per cent payload and 60 per cent engine, structure, and tank, although the tank

Basic mechanics of boost trajectories for satellite orbits, with emphasis on nuclear rockets. As payload increases, the nuclear powered mission shows advantages in take-off weight and thrust.

PROPULSION APPLIED TO Satellite Boosting

weight is smaller in this case. For gross weights based on these estimates are then 3.52 M for the nuclear and 6.75 M for the chemical. This is not an actual design estimate, but serves to indicate the decisive advantages of improved performance, even with a heavier engine. Some improvement in the weight of the chemical system might result from staging the missile.

Orbits

The properties of satellite orbits about a planet can generally be derived from single-body, two-dimensional, classical mechanics [5]. For exact determination of satellite lifetimes, an accurate model of the earth's gravitational field and atmosphere should be used, but for calculating the first-order characteristics of orbits, it is sufficiently accurate to consider the earth as a point-mass center of attraction of strength g_0R_0 ($\approx$ 24.2 miles^2 per sec^2). Then the total energy of a particle in a circular orbit is $g_0R_0(1 - 1/2k)$, where k is the radius of the orbit in terms of R_0. For each radius, there corresponds a definite velocity, period, and energy requirement. A similar relationship can be worked out for elliptic orbits. If the total energy of the particle is less than the strength of the gravitational center, it will describe either a circular or elliptical periodic orbit about the attracting point. If the total energy is greater than the strength of the gravity field, the particle will be on an open, nonperiodic orbit and escape the Earth along a parabolic or hyperbolic path.

At an ideal velocity, a particle moving in free space will have the escape energy in motion. For example, escape energy of 24.2 miles^2 per sec^2 corresponds to a velocity of 6.95 miles per sec, or about 37,000 fps. The escape, or parabolic, velocity at any altitude is $\sqrt{2}$ times the circular velocity at that altitude. A computation of the mass ratio along the boost trajectory to the orbit can be considered then as an exact calculation of the energy losses involved in the flight. The optimum trajectory is that path for which the velocity increment due to loss is the least.

The characteristics of some representative orbits should be mentioned. For an orbit of 100 miles altitude, the ideal energy velocity is 26,300 fps and the orbital velocity is 25,700 fps with a period of about 88 min. At 500 miles, the ideal velocity has increased to 27,400 fps, but the circular velocity has decreased to 24,500 fps. The period is slightly over 100 min. As the orbit radius increases, the ideal velocity approaches the escape velocity and the circular velocity continues to decrease. There is one radius whose period corresponds to that of the rotation of the Earth. This is the stationary orbit at 22,300 miles altitude. A vehicle in this orbit would have a velocity of 10,000 fps, but viewed from some equatorial point would apparently oscillate about the zenith point in a narrow diurnal ellipse along the longitudinal meridian. If the orbit were equatorial, then the vehicle would appear to hang motionless in the sky. The ideal velocity of the stationary orbit is 35,500 fps, or 92.4 per cent of the escape energy. The high orbits are literally on the threshold of space—that is, the capability of reaching an outer orbit is tantamount to the capability of accomplishing a space mission.

The ideal velocity is only a theoretical lower bound for the mission energy. Since the losses appearing in the formula for mass ratio result from both conservative and nonconservative forces, different paths or firing modes between two paths can require quite different mission velocities. In general, a thrust-direction program which acts against gravity, that is, radially, is less efficient in increasing the vehicle energy than a program which fires more in an azimuthal direction, although in most cases the radial thrust produces the shortest trip time between potential energy levels. The problem of selecting the optimum firing and thrust-direction program has been studied extensively by machine computation and the calculus of variations. For the case of the airless, nonrotating Earth, Fried [6] and Perkins [7] have independently shown that an optimum trajectory results from the tangent of the thrust angle with the local horizontal decreasing linearly in time; that is, the

direction of thrust decreases from nearly straight up at take-off to horizontal at orbit injection according to a linear decrease of a tangent. In actual practice, the effects of the atmosphere and the rotation of the Earth cannot be neglected, but a solution can still be obtained by machine computation.

For reaching the higher orbits, use should be made of the Hohmann ellipse. The injection point will be the perigee of the ellipse, and the apogee will lie at a higher altitude on the opposite side of the Earth. By firing again at apogee, the velocity of the vehicle can be increased to the correct value so that it remains in a circular orbit at the higher altitude. It was proved by Hohmann that impulsive firing at the apogee and perigee of the ellipse results in a minimum expenditure of energy for transfer between circular orbit levels. It may be desirable, however, for a vehicle to reach high-altitude injection within the horizon of the launching site rather than on the opposite side of the earth, for reasons of control or guidance. In this case, the firing program would be similar to that for a low-altitude orbit except that long coasting periods of climb would be necessary. The mass-ratio expenditure would be at least nearly double that of the optimum Hohmann launch program [8].

Mass Ratio

Some characteristics of the launch using the stationary orbit as an example will be examined. Using the formula for mass ratio,

$$R = \left(1 - \frac{f}{I} t_b\right)^{-1}$$

where t_b is the burning time for the engine, I is the specific impulse, and f is the thrust-to-weight ratio at take-off (these parameters are taken as average and fixed for the trip), and remembering the relation between mission velocity and mass ratio, then a vehicle with an $f = 1.4$ and $I = 900$ sec reaches a mission velocity of 40,000 fps in 480 sec of engine burning. Furthermore, the maximum radial (upward) velocity must decrease with altitude or the rocket will exceed escape velocity at that altitude. A simple numerical integration of the motion of a falling particle will show that it takes 15,000 sec for a particle to fall straight down from the stationary orbit under the influence of gravity. Kepler's law for the period of revolution of planetary bodies gives around 40,000 sec for Hohmann transfer ellipses to the stationary orbit. Thus the trip time to reach this orbit must lie between 15,000 and 20,000 sec, unless a vehicle is used which exceeds the free-fall velocity along the climb and uses thrust to cancel the excess rise at the desired orbital altitude. The difference between 480 sec and 15,000 sec is an indication of the magnitude of the coast period, or period of greatly reduced thrust, which must be used to guide the vehicle correctly through the high-altitude boost.

A nuclear vehicle would not have a prohibitive mass ratio for missions of around escape energy. For 900-sec impulse, a mass ratio of 5 corresponds to 46,500 fps. If partial staging, that is, dropping of empty tank structure, could be employed, the corresponding mission velocity can be extended. Since chemical rockets for mission velocities of this magnitude must employ several stages, the nuclear rocket is competing with several stages of chemical rockets. The trajectory for the nuclear is slightly different from that for the chemical. One reason is the control problem at thrust cut-off [9]. Another is the possible desire to have the nuclear rocket climb through the atmosphere in the shortest length of time. Both factors increase mission velocity slightly, but the capability of the engine derived from the higher impulse more than offsets these.

Single and Multiple Stages

For missions much beyond escape, the nuclear vehicle will probably have to be staged, limiting the range of mission velocity in which the single-stage nuclear rocket can excel. This range corresponds to boosting large payloads into orbit or the initial stage of a space mission. Both tasks can be performed by a chemical system, but much higher thrust per pound of payload will be required. For the space mission, a single-stage nuclear rocket may be used to accelerate the payload directly into the ballistic interplanetary-transfer orbit. There will be a small guidance error resulting from the fact that the ballistic-transfer injection occurs too close to the Earth [2, 10] Furthermore, the single-stage nuclear vehicle may have enough propellant available after injection to retrofire and re-enter the atmosphere as a glide or parachuted vehicle coasting to some preselected landing region. Thus the valuable power plant would be recoverable for processing and re-use.

While the use of any nuclear reactor creates a possible radiation hazard, there exists a radiation hazard in space itself. Protection from both may not be much more of a problem than protection from either one [1, 11].

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Electrochemical phenomena offer the only technically feasible means of storage of solar energy for small stationary solar power plants. A large reduction in the cost of such devices is required for economic use.

ELECTRICAL STORAGE OF Solar Energy

By H. L. Foote, Jr., R. C. Shair, and D. H. Smith,

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THE current technical feasibility of methods of storage and their economic aspects have been examined by the authors in order to uncover and develop some of the problems of storage that must be solved before a practical electrical power output can be obtained from solar energy.

The use of secondary batteries for storage of electrical energy appears to be taken for granted, in other studies of this subject, and Daniels has stated that large reductions in battery cost are necessary,[1] before economical operations can be realized. While apparently storage batteries are the only available means for storage, it is desirable to compare them with other possible methods of storage and to confirm this assumption if possible.

Energy Storage in General

The necessary characteristics of an electrical storage system for solar energy are determined both by the nature of the solar-energy source and the demands of the load. A practical storage system must: (*a*) receive energy at high rates; (*b*) deliver energy at high rates; (*c*) receive and discharge energy with high efficiency; (*d*) have a low self-discharge characteristic; (*e*) serve as an impedance-matching device between solar converter and load; (*f*) be capable of a large number of charge-discharge cycles; and (*g*) be cheap to manufacture and have a long useful life. For low power devices some of these considerations may be relatively unimportant, but for higher power ones—from approximately 50 watts and up—they become significant.

Energy-storage data for representative examples of the available storage methods have been compiled, Fig. 1. Storage capacities for each phenomenon and system vary over a wide range of values. This presentation does not include the over-all conversion efficiency. When the cyclic efficiency is included and when systems with limited storage capacity are omitted, only chemical systems are left, Fig. 2, and of these the electrochemical ones are the most attractive.

Electrochemical Energy Storage Cost

It is desirable to determine the economic merit of electrochemical storage systems in combination with a solar energy source relative to alternative sources of electrical energy. This has been done by comparing the cost of electrical energy supplied by solar plants with that of power-line plants and primary-battery power plants—the normal energy sources for telephone usage. These cost estimates are over-all costs and include the rectifier or primary battery, housing, emergency reserve, power transmission lines, power maintenance, and the cost of financing. This estimate, Fig. 3, shows that costs at low power levels vary widely, from about $13 per kwhr at one watt to about 45 cents per kwhr at one kw. Curve G represents costs equal to one half of those of the primary-battery and power-line plants (i.e., $1/2$ of lower curve A and of curve C). Costs specified by curve G represent an upper limit of cost for an electrical storage system, as discussed below.

Reduction in Storage Costs

For purposes of analysis, it is arbitrarily assumed that the solar-energy converter and the electrical storage contribute equally to solar-plant cost. Although this assumption may appear to ignore the considerable problems that would be encountered in solar-converter development, it is approximately right and its use permits a comparison to be made between the present cost of stor-

[1] Farrington Daniels, "Utilization of Solar Energy," in "New United Nations, New Sources of Energy and Economic Development," New York, N. Y., 1957, p. 40.

Based on a paper contributed by the Solar Energy Application Committee and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

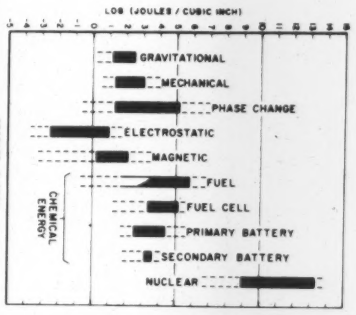


Fig. 1 Energy-storage capacity per unit volume for various methods of storage—in principle the energy change involved in each of these phenomena could be realized in a storage system by means of an electrical coupling scheme. Such schemes are known for most of the phenomena.

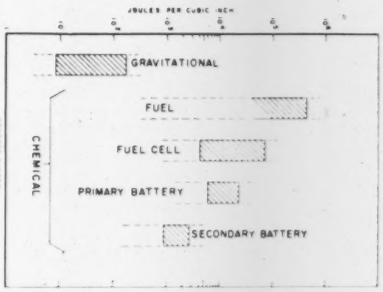


Fig. 2 Electrical-storage capacity per unit volume of practical systems—these are storage capacities for the systems of Fig. 1 after including cyclic efficiency. Most of the possibilities shown in Fig. 1 have been eliminated because of their technically undeveloped status at this time

Solar Energy

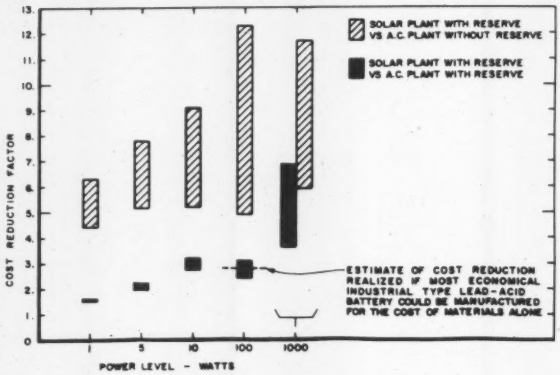
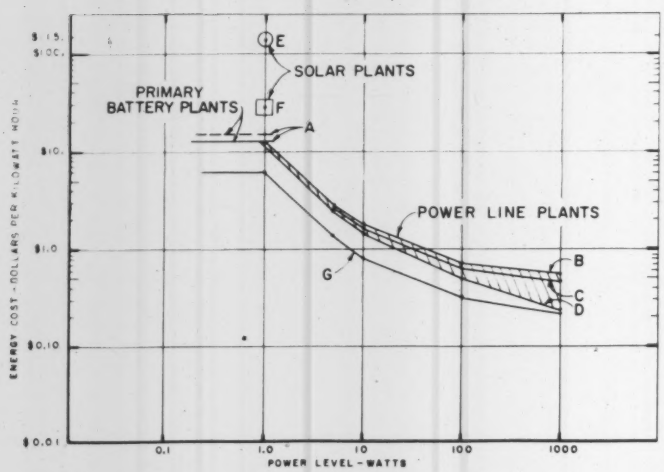

SOLAR PLANT WITH RESERVE VS A.C. PLANT WITHOUT RESERVE
SOLAR PLANT WITH RESERVE VS A.C. PLANT WITH RESERVE
ESTIMATE OF COST REDUCTION REALIZED IF MOST ECONOMICAL INDUSTRIAL TYPE LEAD-ACID BATTERY COULD BE MANUFACTURED FOR THE COST OF MATERIALS ALONE
COST REDUCTION FACTOR
POWER LEVEL - WATTS

Fig. 4 ▶ An estimate of lead-acid-battery cost reduction required in order to make solar power plants competitive with alternative power sources. The hatched bars show range of comparison for a power-line plant with no reserve, supplying an a-c load (top of bars) and a d-c load (bottom of bars), with a 96-hr reserve-storage solar plant. The comparison shown by the solid bars is that of a 24-hr and a 96-hr reserve a-c plant supplying a d-c load with a 300-hr reserve solar plant. These estimates are based upon the data of Fig. 3 and are for the most unfavorable case—the short transmission line.



◀ Fig. 3 Cost of electrical energy obtained from power-line and primary-battery power plants—the normal energy sources for telephone usage. Curve **A** shows energy costs for two primary-battery plants. Curves **B**, **C**, and **D** show costs for power-line plants with power-transmission lines shorter than 500 ft, having respectively 7, 4, and 1-day emergency-storage capacity. Point **E** is the cost for the 1-watt solar plant actually constructed. Point **F** is a more recent cost estimate for this plant based on the use of lower-cost silicon diodes. Curve **G** assumes a reduction of costs to one half those of the primary-battery and power-line plants (curves **A** and **C**).

age systems and an estimated maximum cost, shown as curve G in Fig. 3, which must not be exceeded if economical operation is to be obtained. The results of the analysis are in the form of storage-system cost-reduction factors, shown in Fig. 4, for plants which would provide firm power to telephone company standards, in the power range from 1 watt to 1 kw. A two to fourfold reduction in storage cost is required for economic operation (solid bars in Fig. 4). An analysis of the realizability of these cost-reduction factors with respect to the items that contribute to the cost of a storage system is shown in Fig. 5 for a storage system using lead-acid batteries. At low powers the indicated improvement might be obtained by improving the operating characteristics of batteries, to reduce auxiliary expense. At high powers the cost of the battery itself must be reduced.

Choice of Battery

Secondary batteries are immediately suitable technically, but require considerable reduction in cost to make them suitable economically. Assuming that the required reductions can be made, we find basic differences in the pertinent characteristics, as listed in Table 1.

The most common storage battery used today is the lead-sulfuric-acid battery.[2] The advantages of this battery are its low cost, the utilization of readily available raw materials in its construction, and generally favorable operating characteristics. The principal shortcoming of the lead-acid battery is its poor low-temperature charging characteristic.

The nickel-iron battery is less desirable than other batteries because of its low efficiency. Its use would require that a solar collector of greater capacity be provided thus increasing costs.

The nickel-cadmium system is available with either the pocket-type or the more compact sintered-type plates. These batteries can be charged and discharged at very high rates and have a low self-discharge rate.

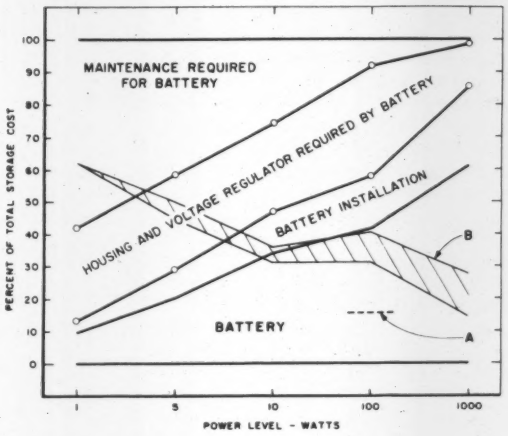
The recent development of the sealed nickel-cadmium

TABLE 1 TECHNICAL DATA ON ELECTROCHEMICAL STORAGE SYSTEMS

System	Watt-hr per cu in.	Watt-hr per lb	Efficiency, per cent[a] Amp-hr	Watt-hr
Lead-acid	0.8	10	90	81
Nickel-iron	0.7	12	75–80	60–64
Vented pocket-type nickel-cadmium	0.4	8	80	68
Vented sintered-type nickel-cadmium	1.2	14	80	70
Sealed nickel-cadmium	1.8	14	80	72

[a] Based on 5 to 8-hr charge rate and 30 to 50-hr discharge rate.

[2] R. C. Shair, "Lead-Acid Storage Batteries in Telephone Service," AIEE Conference Paper No. 58-404, February, 1958.



◀ Fig. 5 Breakdown of total storage costs into significant categories for a solar power plant with 300-hr reserve capacity. The breakdown is shown for the same power range and conditions applicable to Figs. 3 and 4 and for the lead-acid battery. Dashed line A has the same significance as the dashed line in Fig. 4, that is, the fraction of battery cost represented by the raw materials required for its construction. Curve B is a replot of the improvement-factor data for the firm-power case (solid bars of Fig. 4). It shows the percentage cost to which the storage cost must be reduced for a solar plant to be competitive with a power-line plant. This chart shows that the indicated improvement might be obtained at low powers by improving the operating characteristics of the battery so as to eliminate or reduce auxiliary expense. At high powers the cost of the battery itself must be reduced.

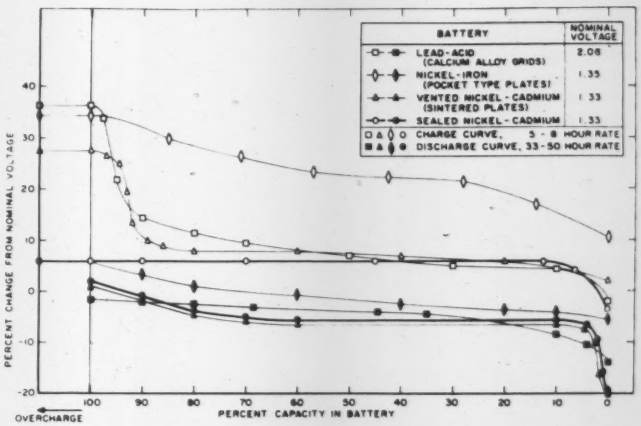


Fig. 6 ▶ Variation of battery voltage during cycling—this figure shows that wide fluctuations of voltage can be expected in a solar power plant that uses presently available secondary batteries. The output voltage of a solar power plant will vary depending upon the state of charge of the battery, and from night to day, and as the sun may be occluded during the day. This relatively unfavorable characteristic of electro chemical storage systems requires either that the load be tolerant of voltage change or that an output voltage regulator be provided.

battery presents a very attractive means of storing and regulating the electrical output of a solar-energy transducer. Unfortunately, the present cost of these sealed batteries is about four to eight times that of lead-acid batteries, but some economies are realized in maintenance and in the electrical circuitry used for regulating load voltage, because of the inherent voltage-limiting capability of this system. This capability, illustrated in Fig. 6, shows the percentage change in voltage experienced with a sealed nickel-cadmium battery over its charge and discharge cycles. This favorable voltage characteristic is compared with that of the other battery systems considered.

A 1-Watt Storage System

Field experience with an experimental 1-watt solar power plant which utilized silicon solar diodes and the sealed nickel-cadmium battery has been summarized elsewhere.[3] Analysis of this experiment leads to the conclusion that an electrical storage system can be designed to provide, in conjunction with suitable silicon photodiodes, trouble-free operation of rural-carrier telephone equipment with no other energy source than the sun. This demonstration of technical feasibility at the 1-watt level was, however, coupled with the finding that the over-all power plant was not economically competitive with either a power-line-rectifier lead-acid system, or with an air-depolarized primary-battery system, both of which are now provided as standard power plants for the rural-carrier telephone equipment.[4]

Conclusions

1 Electrochemical storage is at present the most attractive technical method for storing energy electrically, and battery systems currently available such as the lead-acid or nickel-alkaline types are technically feasible for solar-energy storage.

2 No electrical storage system is presently economical for the storage of solar energy. Estimates indicate that a two to tenfold reduction in cost of storage-battery systems is necessary to achieve economic solar-energy usage.

3 It is the opinion of the authors that the present methods of constructing electrochemical storage devices will not permit the necessary reduction of cost. It will be necessary to explore new ideas and new methods of constructing storage batteries, to investigate other electrochemical systems such as the primary-battery ones, and to accelerate development of storage systems based upon use of the fuel cell.

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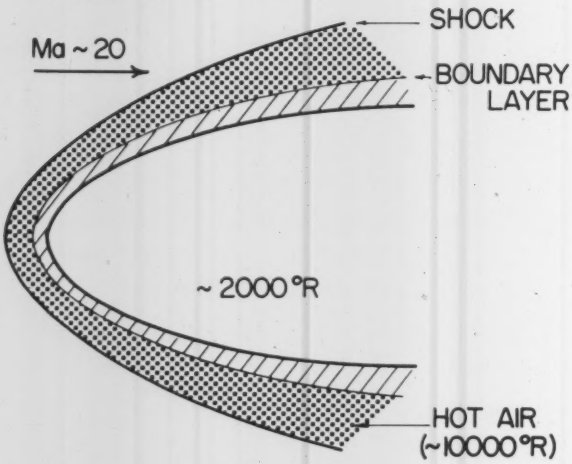

The shock ahead of a space vehicle. Studies have been made on dissociation and the possibility of reducing heat transfer by non-catalytic surfaces

A Review of HEAT TRANSFER Literature 1958

By E. R. G. Eckert,[1] Mem. ASME, **J. P. Hartnett,** Mem. ASME, **and T. F. Irvine, Jr.**[1]

For missiles, and for revolutionary power plants and processes, the control of heat is critical. In the world of heat transfer, the lead time between science and engineering has all but disappeared.

This report first appeared in the March, 1959, issue of *Industrial and Engineering Chemistry*, a publication of the American Chemical Society.

ACKNOWLEDGMENT: The authors wish to acknowledge the assistance of the staffs of the several libraries of the University of Minnesota. Their courteous and interested help has been invaluable in the preparation of this survey. Special thanks are also due to Mrs. J. Siewert and Miss S. Hofer for their aid in typing the manuscript.

THE number of papers in the field of heat transfer, which in 1957 exceeded one thousand, is still on the increase. Translations of papers from Soviet technical periodicals are now available to a considerable degree (abstracts and translations may be obtained through the U. S. Department of Commerce). The large number of publications makes it necessary to restrict this presentation strictly to papers dealing with heat transfer and to leave out those which cover physical processes, even when they are intimately connected with energy transfer, like boundary-layer flow and thermal properties.

Books on heat transfer which have been published during the past year are contained in Table 1.

Conduction

A number of papers investigated the influence of standard assumptions made in the analysis of classical conduction problems. A study [10A][2] of prismatic fins, with side heat losses proportional to the $^5/_4$ power of the temperature rather than the first power, gives an insight into the situation when a single fin is losing heat by free rather than forced convection. Another paper [17A] investigates the efficiency of fins when the heat-transfer coefficient is significantly greater at the tip than the root.

An experimental paper [16A] reports heat-transfer measurements on various extended surfaces and illustrates the use of this information in design. Another investigation [12A] has collected the extensive and scattered information on finned surfaces and arranged it in a convenient manner. Special attention is paid to the optimum dimensions of fins.

Two papers [33A, 7A] are devoted to the problem of one-dimensional transient heat conduction, where the physical properties are variable. Significant errors may arise if this property variation is neglected. Two other studies [32A, 5A] report on the calculation of the thermal conductivity of a medium having dispersed particles of a substance with a different thermal conductivity.

Regarding phase changes and moving boundaries: An extension of Schmidt's graphical method to freezing problems is discussed in [13A], and numerical solutions are investigated in [6A]. In applications such as aerodynamic heating upon entering a planet's atmosphere, information is desired on the effects of using a high-velocity boundary layer as the boundary condition to the change-of-phase conduction problem. Two papers [28A, 23A] deal with this situation and study, in particular the region of the stagnation point, where aerodynamic heating effects are most severe.

One-dimensional transient-heat-conduction solutions are useful for estimating heat loads likely to be met in practice. A number of investigations [18A, 9A, 8A, 27A] are concerned with the infinite-wall problem, where one side of the wall is insulated and the other side is subjected to a variety of conditions. Of even greater practical interest is when two or more infinite slabs are placed in contact forming a composite wall. Six papers

[1] Mechanical Engineering Department, University of Minnesota, Minneapolis, Minn.

[2] Numbers in brackets designate References at end of paper.

[2A, 30A, 24A, 14A, 31A, 3A] study this situation and present both integrated and numerical solutions. An additional investigation [25A] is concerned with the two-layer wall having a thermal contact resistance between the layers.

A new set of charts showing rates of temperature change in plates, cylinders, and spheres is reported [19A]. Chart samples are shown and discussed. A method is discussed [11A] for obtaining general unsteady-state solutions of various shaped solids in terms of the transient solution in a semi-infinite slab.

Regarding a heat pulse applied to a restricted region on a surface: One study [22A] investigates this problem when the heat pulse is applied to a small circular area on an infinite two-dimensional region. The solution satisfies general boundary conditions, including surface temperature distributions which are periodic with respect to time. Another paper [29A] treats a similar problem, both in an infinitely thin sheet and in a semi-infinite solid.

Three cases of unsteady heat flow in infinitely long cylinders have been reported. In one [15A], the boundary temperatures are changing periodically with time; in another [4A], the boundary temperatures are an arbitrary function of time; and in [21A], the cylinder is exchanging heat with a coaxial thin-walled tube.

Three papers dealt with steady-state problems: The use of conformal mapping [1A] to find the temperature distributions in a solid containing a number of rectangular channels; solutions for radial and longitudinal temperatures in electrically heated finite cylinders [20A]; an electric-analog determination of shape factors over a large range of parameters [26A] for circles in squares and rectangles, and concentric squares and rectangles.

Channel Flow

The theory of laminar flow in tubes has been expanded. An extension of the Graetz problem to situations encompassing variable heat sources in both the radial and longitudinal direction has been reported [33B]. A similar solution, where the fluid enters the tube with an arbitrary temperature profile and is under the influence of frictional heat generation, is described in [35B]. The latter analysis is general enough to cover both Newtonian and non-Newtonian fluids.

Laminar forced convection in circular tubes with prescribed wall heat flux has been studied [28B]. A general solution of this type of flow [30B] covers the conditions of axial heat conduction, viscous dissipation, and prescribed heat-generation distribution. Another study [16B] reports on the influence of axial conduction in laminar circular-tube heat transfer, and on the prediction of thermal entry lengths. Three problems are discussed in [29B]: heat transfer by laminar flow, both in circular tubes and concentric annuli, and the decay of swirl in a cylindrical channel.

Laminar flow in ducts having noncircular cross sections is solved [2B] for flow in an annulus with porous walls; another study [19B] considers the problem of laminar forced convection between parallel plates where the internal heat generation decreases parabolically with distance from the wall. Calculations on laminar fully developed heat transfer in a duct having the shape of a circular sector are discussed [8B]. A comprehensive evaluation and summary of over 900 measurements of heat transfer to water in turbulent flow in internally heated annuli have been presented [34B].

Non-Newtonian flow in channels: Analyses for fluids having both Bingham and power-law-type characteristics in annuli are reported [11B], and heat transfer with frictional dissipation has been studied for such fluids in tubes [24B]. A related paper [37B] investigates convection in round tubes with arbitrary velocity distributions.

Flow and heat-transfer characteristics in channels under transient conditions: One investigation, with applications to reactor design [20B], considers a channel having a wall heat source whose strength varies with both time and location as the fluid undergoes a step change in flow rate. Another study [4B] presents stability criteria for forced water circulation through heated passages when the heat input varies with time.

The justification of applying turbulent steady-state convective heat-transfer relations to unsteady-state situations has been investigated [26B]. Conditions under which such an approach may be used are outlined. Unsteady laminar flow between parallel plates is discussed [6B].

Heat transfer to and from fully developed turbulent flow in tubes, and between parallel plates, has been investigated [14B]. A new relation for the eddy diffusivity of heat is proposed. A program which studied turbulent heat transfer in tubes under conditions of significant physical-property variations is reported [21B].

An equivalent Poiseuille law is described for the velocity profile for fully developed turbulent flow in a tube [12B]. A companion paper [23B] presents correlations for the local velocity in tubes, annuli, and parallel plates. A pair of papers [31B, 22B] report respectively on measurements of the eddy-diffusivity ratio, and of eddy viscosities and mixing lengths.

A method for estimating laminar entrance-pressure losses in ducts, with noncircular cross sections, is outlined in [7B], and a second study [36B] recommends procedures for predicting fully developed pressure losses in noncircular ducts for both laminar and turbulent flow. An experimental investigation [17B] reports on pressure-drop measurements for parallel flow through rod bundles. The data are in substantial agreement with the calculation procedure in [5B] which may also predict pressure drop and heat transfer in fully developed turbulent flow in noncircular ducts.

An experimental program to study both friction and heat transfer in rough tubes [13B] directs attention toward determining the effect of Prandtl-number variations on the heat transfer. Another investigation [10B] discusses an analytical method for predicting pressure drop in rough tubes of noncircular cross section. An analysis of turbulent heat transfer in the thermal-entrance region of a tube with uniform wall heat flux is reported in [32B]: Predictions of thermal entrancr length are given for fluids with Prandtl numbers varyine from 0.7 to 100, in a Reynolds-number range betweeg 50,000 and 500,000. An experimental study on the samn subject [38B] reports turbulent entrance heat-transfee measurements for air flowing in a tube, with temperatures as high as 2000 F when the walls were maintained at 100 F.

HEAT TRANSFER

For laminar and turbulent flow in a circular tube where a single phase (gas) reaction is taking place [25B], it is found that conventional heat-transfer relations may be used if suitable effective physical properties are defined and utilized. A related investigation [3B] studied turbulent heat transfer in a tube with a dissociating gas.

Friction and heat transfer in swirling flow in a tube: An experimental program was reported [15B] where the turbulent heat transfer increased by as much as a factor of 4 when the swirl velocity was of the same order of magnitude as the axial velocity. Heat transfer in swirling laminar pipe flow is analyzed [27B] and a calculation method is recommended [9B] for a similar type of turbulent flow.

Heat transfer in a tube under laminar transitional and turbulent conditions, when the flow is pulsating, is discussed [18B]; also an analytic solution for the heat transfer from radiating media moving in a cylindrical channel [1B].

Boundary Layer Flow

Boundary-Layer Solutions. New or more exact solutions have been worked out for various laminar boundary-layer flows. Heat transfer and recovery temperature in a liquid with a very small Prandtl number were calculated on the assumption that the thermal boundary layer is by an order of magnitude larger than the velocity boundary layer [30C]. Additional calculations on the temperature recovery factor r verified the equation by Morgan [52C]:

$$r = \sqrt{\text{Pr}}(0.9242 + 0.194\sqrt{\text{Pr}})$$

Prandtl-number effects were also studied in unsteady forced convection, and the limits to which heat transfer can be calculated by its quasi-steady value were established [49C, 51C] for conditions where the flight velocity and surface temperature vary with time. The effect of an externally generated vorticity on laminar heat transfer near a stagnation point was analyzed [27C]; in an example, an increase by 13 per cent as compared to the normal boundary-layer situation was found. Such a vorticity exists, for instance, behind a detached shock in supersonic flow.

Vibration was found to affect heat transfer from a wire to an air flow parallel to its axis [1C]. A calculation of heat transfer and temperature recovery along a windward stream line on a cone at an angle of attack in supersonic flow [34C] shows that the recovery factor is approximately equal to the square root of the Prandtl number, and that the heat-transfer coefficient increases with increased angle of attack. Stewartson's transformation of the compressible boundary layer was extended to turbulent flow [26C]. Velocity and temperature profiles in a constant-property laminar boundary layer with a power-function free-stream velocity and wall-temperature distribution are reported [22C].

Boundary-layer solutions, including heat transfer, for flow with arbitrary velocity and wall-temperature distributions: The classical paper by Frössling has been translated [17C]; an asymptotic series solution, valid for large distances from the leading edge, has been developed [6C]; Görtler's series method [18C] has been extended to heat-transfer calculations [50C]. Finite-difference procedures have been applied to compressible-boundary-layer calculations [2C, 20C, 45C]. The similarity, which exists in a highly cooled boundary layer and which was pointed out by Lees, has been utilized [33C].

Integral methods for boundary-layer calculations have been extended to hypersonic heat transfer [24C], to heat transfer with arbitrary pressure gradients [35C, 37C], to turbulent flow [57C], and to varying wall temperatures [48C]. The procedures were reduced to quadratures [47C, 12C, 23C]. The well-known heat-transfer formula by Lighthill has been rederived in a simple way [25C]. The effect of property evaluations on heat transfer was investigated for laminar [3C] and for turbulent flows [13C].

Dissociation and Chemical Reactions. In the re-entry of fast vehicles like satellites or missiles, the boundary layers develop within a region of air at extremely high temperature: Consequently, dissociation and even ionization will occur. Regarding the influence of dissociation on heat transfer to the surfaces of these vehicles near their stagnation point, most calculations assume a Lewis number approximately equal to 1. Frozen state or thermal equilibrium within the boundary layer, and catalytic or noncatalytic surfaces, have been considered [16C] and compared with experiments [38C]. The calculations have been extended to turbulent boundary layers [21C, 32C, 39C] and to finite recombination rates [19C]. The stability of the flow near a stagnation point, and the influence of a mass transfer from the surface into the boundary layer on heat transfer, have been investigated [56C].

The surfaces of vehicles in the re-entry process may be heated to such a degree that the material evaporates or sublimes. The gases created in this way undergo chemical reactions in the boundary layer, or surface combustion may occur. Calculations based on simplifying assumptions indicate that heat transfer is not expected to change very much by the influence of such reactions [14C]. More detailed calculations have been made [7C, 9C, 43C, 44C] and have essentially verified this conclusion.

Combustion in a boundary layer is a process similar to heat transfer from a boundary layer containing heat sources. It was shown that this situation can be reduced to heat transfer without sources by defining the heat-transfer coefficient as the heat flux per unit difference between actual and adiabatic wall temperature [58C]. The surfaces of re-entering objects may also melt under the influence of the absorbed heat. In this way a liquid film exists between the solid surface and the gas boundary layer [36C, 54C].

Magnetohydrodynamics. At extremely high flight velocities, the air will even be ionized and will then be subject to magnetic and electric forces. Such conditions are also found in the plasma utilized in the attempts to

obtain controlled fusion as a source of nuclear power. As a consequence, heat transfer in this area, called magnetohydrodynamics, has been studied extensively [29C, 46C]. Flat-plate flows [40C] as well as stagnation-point flow [41C, 31C] and Couette flow [5C] have been considered. It appears generally that a reasonable magnetic field can reduce friction considerably and heat transfer to a lesser degree.

Heat transfer in slip flow: The heat flow to a surface has to consider a term which describes the work done by shear at the surface as well as the heat flow by conduction [28C].

Experimental Investigations. Experiments have been carried out for laminar and turbulent boundary layers with or without blunt leading edge [4C, 8C, 11C] for hemisphere-cylinder combinations at Mach numbers up to 6.8 [10C], for flat-faced cylinders [53C], for turbulent boundary layers in supersonic flow to Mach numbers equal 5 [55C], and for low-velocity flow with varying wall temperature [15C]. Experiments in a shock tube on the stagnation point of spheres have been performed at temperatures up to 7900 F [42C]. Generally, the measured heat-transfer coefficients compare well with calculations.

Flow With Separated Regions

Engineering practice is sometimes concerned about heat transfer to bodies with irregular shapes. A recent paper attempts to find relations for heat and mass transfer which can be used as a first approximation for shapes for which no experiments are available [11D].

Heat transfer in the separated region of blunt objects exposed to supersonic flow is of interest for the development of missiles and satellites. The results of experiments are contradictory in this area. Some measurements found low heat-transfer coefficients equal to 12 per cent of the value at stagnation point [2D]. Other measurements determined coefficients at the center of the downstream surface of a hemisphere-cylinder combination at Mach numbers up to 5, which were as large as the values upstream of the flow separation point [12D]. The recovery factor on a sphere was found to be approximately as high in the separated region as on the front portion [2D].

Previous findings that stream turbulence increases the heat transfer in a laminar boundary layer have been verified [9D]. The average heat-transfer coefficient was found to depend on intensity and scale of free-stream turbulence [15D]. Increases up to 30 per cent were observed. Heat and mass transfer to disks normal to a jet of air have been measured for Reynolds numbers between 2000 and 600,000 [14D]. Heat transfer to a sphere at the transition from free molecular flow was analyzed [7D].

A number of investigations give further information on heat transfer and pressure drop of air flowing across tube banks for Reynolds numbers between 600 and 40,000 [8D, 6D]. Internal leakages in baffled heat exchangers were found to decrease the heat-transfer coefficients to 50 per cent and the pressure drop to 30 per cent of the value obtained without leakages [3D].

Heat transfer in packed beds of spheres, cylinders, and cubes—with air, hydrogen, or carbon-dioxide flow—were measured with improved apparatus in which the bed was heated by high-frequency induction [1D, 5D]. Solutions to the basic differential equations describing unsteady heat transfer in a packed bed were obtained by the use of Fourier integrals [13D]. General correlations and comparisons were made, on existing experimental data, for heat transfer between fluidized beds and bounding surfaces [16D], and some new experiments on fluidized systems of various engineering materials showed that heat transfer increases suddenly with the onset of fluidization [10D]. For the calculation of blade temperatures in gas turbines, knowledge of the temperature field in the approaching gas stream is required and suffers considerable rearrangement if it moves through a bend between combustion chamber and blades [4D].

Transfer Mechanism

Transition to Turbulence. The most difficult problem in heat-transfer calculations is to predict the location where transition from laminar to turbulent flow occurs. Results of experiments at supersonic velocities have verified that transition is delayed on smooth cones by surface cooling. Stream turbulence or surface roughness induces transition. However, it was found that these effects decrease with increasing Mach number [19E]. Extreme cooling of a surface was observed to have the peculiar—and up to now, unexplained—effect of promoting transition [14E]. In the flow over blunt bodies and cylinders, the fluid in the boundary layer is exposed to centrifugal forces. An analysis shows that these forces have generally a stabilizing effect [15E].

Detailed studies [9E] and observations by smoke visualization [2E] of the transition process show instability waves and turbulent bursts. An analysis of previous experiments clarifies the combined effects of turbulence and roughness on transition [10E]. The recovery temperature is changed near a roughness element when the boundary layer is turbulent. The direction of this change and its amount was found to be very dependent on the shape of the element. With certain types of roughness the average recovery factor was reduced to 0.85 as compared with a value 0.88 on an equivalent smooth surface [3E].

Established Turbulence. Intensive analytical and experimental work continued on the detailed nature of established turbulence. The partition of energy between velocity and magetic fields is analyzed for hydromagnetic turbulence [4E]. Diffusion [1E] and interactions between the various transfer processes [6E], and universal functions describing turbulent parameters in shear flow [12E, 16E] and in eddies [7E] have been re-

ported. A detailed study of local heat and mass transfer on the surface of a sphere also includes information on the various boundary-layer profiles [13E, 17E]. Heat transfer in isotropic turbulence [11E] and in turbulent jets [18E] have been investigated by analysis and experiments.

The thermal-diffusion factor has been found to be considerably larger in ionized gases than in neutral ones [5E]. A simple theory of an idealized turbulent mixer on the basis of stationary isotropic turbulence predicts the rate of decrease in concentration fluctuations of a contaminent as a function of the turbulent scale and power input [8E].

Natural Convection

Although the major emphasis in natural convection during the past year was directed to fluids in enclosed spaces, there also appeared a number of papers dealing with vertical flat plates and cylinders. For the nonisothermal vertical plate, similar solutions were found possible if the temperature difference between the plate surface and the surrounding air varied either as a power function or as an exponential from the plate leading edge [7F, 18F]. These results, valid for fluids with Prandtl numbers of 0.7 [7F, 18F] and 1.0 [18F], demonstrate that appreciable errors may occur if isothermal results are used for nonisothermal conditions. Similar results for free convection from the outer surface of a vertical circular cylinder are also available [6F].

For an isothermal plate held at a temperature appreciably different from that of the surroundings, it is necessary to take into account the physical property variations. For gases and for mercury the constant-property solutions may be used, provided the physical properties are evaluated at a specified reference temperature [19F]. An unusual case of variable physical properties not treated in [19F] is encountered when a vertical plate at a temperature above 4 C is placed in water held at a temperature below 4 C (i.e., the temperature at which the density of water exhibits a maximum). An experimental investigation of this is reported; an integral analysis is developed, which gives good agreement with the experimental data [14F].

The method of characteristics is employed to analyze transient free convection from a vertical plate initially at thermal equilibrium with its surroundings when suddenly (*a*) the surface temperature is raised to a new and constant value or (*b*) a constant heat input per unit length is imposed on the surface. An unusual result is the finding that the heat transfer exhibits a minimum during the transient period [15F]. An interferometric study of transient free convection from pulse-heated nichrome foils has appeared [3F].

The Benard problem, wherein a thin fluid layer is heated from below: Approximate methods which may be useful in treating more complex instability problems are presented for the simple Benard case, allowing comparison with the available exact solution [13F]. Nusselt numbers are reported for a number of different fluids heated from below [1F, 16F], with one investigation covering a range of Prandtl values from 0.02 to 8750; a single correlation equation gives agreement with the data [1F]. An analytical prediction of the heat transfer is also available and indicates that the Nusselt number increases linearly with Rayleigh number for a Prandtl number of unity [4F]; this result agrees with experiments.

The preferred form of the convection pattern for Benard cells is studied mathematically and it is concluded that square planforms are preferred to hexagonal patterns for fluids with ordinary Prandtl numbers [4F]. An experimental investigation of the effects of the confining lateral boundary geometry on such flow patterns was presented [17F]. Such convection cells sometimes occur even when the critical Rayleigh number is not exceeded. A dimensionless parameter involving the ratio of surface tension forces to viscous forces is advanced for predicting this instability [11F].

A somewhat different problem arises when a thin fluid layer is heated along the top boundary and cooled nonuniformly along its lower surface. Local flows then develop due to temperature differences, and the depth of penetration of those perturbations was determined analytically. The effect of rotation was also considered [20F].

An extensive treatment of free convection in enclosed spaces is presented in a recent translation of a Russian document. The mathematics is discussed in detail and related experimental studies are reported, covering the work of a number of Soviet investigators [10F]. Free convection to fluids confined in vertical tubes closed at the bottom with the side walls having a linear temperature distribution has been analyzed, using an integral method similar to that proposed earlier by Lighthill. The resulting velocity and temperature distribution are presented [9F]. The influence of inclining such a thermosyphon tube heated from the side walls and closed at the boottm is investigated experimentally. For high-Prandtl-number fluids, the heat transfer decreased for small angles of inclination and, on further tilting, the heat-transfer performance again increased to a value above that found for the vertical tube. For water, the effect of inclining the tube was to increase the heat-transfer performance as compared to that found for the vertical [5F].

Free convection to a gas layer contained between two vertical walls held at different temperatures, with the horizontal connecting strips either insulated or having a linear temperature distribution, is analyzed; also the effects of inclining the channel [12F].

Combined free and forced convection [2F, 8F]: For laminar flow in vertical channels, including the influence of frictional heating, two distinct states of flow are predicted over a considerable range of the governing parameters. In other flow regimes no solutions were possible. These analytical conclusions still require experimental verification [8F]. Recent experimental data for superposed free and forced laminar convection in vertical circular tubes are in disagreement with the prediction of Martinelli and Boelter, but a new analysis is presented which gives good agreement with experimental results [2F].

Convection from Rotating Surfaces

The problem of cooling rotating machinery, in particular electrical equipment, has been responsible for several basic heat-transfer investigations. Two such studies involved the flow of air through an annular space with the inner surface rotating [1G, 3G]. For adiabatic flow, four regimes were encountered depending on the Reynolds and Taylor numbers; for the diabatic case with the inner wall heated, heat-transfer results were obtained and demonstrated that the heat transfer under some conditions is decreased by increasing the axial flow [3G]. In a related study, the effects on heat transfer of slotting the confining walls, as encountered in rotorstator combinations, is investigated [1G].

New results are available for heat transfer from rotating cylinders and disks [4G, 6G]. These include free convection from stationary cylinders, forced convection from stationary cylinders, and finally heat transfer from rotating cylinders, with and without cross flow; a generalized correlation is advanced which is valid over the complete range of the experiments [4G]. The early results of Cochran for heat transfer from isothermal disks rotating in air has been extended to include the influence of variable physical properties [6G].

Two investigations, of interest from a meteorological viewpoint, involve the influence on the fluid motion and heat transfer of combined rotation and body forces acting on a fluid mass. An analytical study, treating a layer of fluid contained in a rotating vessel heated from below, revealed that no significant convection effects are generated by rotation alone; indeed, rotation may inhibit the flow and diminish the heat transfer [5G]. In an experimental investigation a column of water contained in an annular ring, with the container walls at different temperatures and with the whole apparatus on a turntable, was studied both visually and quantitatively for flow patterns and heat transfer [2G].

Transpiration Cooling

In addition to several new analyses for laminar flow with mass transfer, there appeared a number of experimental results for transpiration cooling in turbulent flow. The problems of surface melting and chemical reaction, coupled with the mass transfer process, received attention.

Approximate methods have been developed for determining the influence of mass transfer on heat transfer in the region of a stagnation point [15H, 16H, 22H]. At hypersonic Mach numbers the air in the boundary layer near the stagnation point is dissociated and may be considered to consist of air molecules and air atoms; the injection of molecular air into such a region has been analyzed, considering both infinitely slow and infinitely fast reaction rates, and the resulting heat transfer is calculated for specific hypersonic flight conditions [20H]. Laminar flow over a yawed infinite cylinder, in the presence of transpiration cooling, is amenable to exact solutions: The amount of coolant required to maintain a given wall temperature decreases with increasing yaw angle [1H]. The analysis of Frössling treating simultaneous mass, momentum, and energy transfer for laminar flow over an arbitrary body has been translated [7H]. An extensive analysis of mass transfer cooling with hydrogen injection vividly demonstrates the large reductions in heat transfer and skin friction attainable with a light gas; velocity and temperature profiles are also presented for Mach numbers of 0 and 12 [6H]. The advantages of mass transfer cooling in laminar flow have been verified for air injection, showing good agreement with the laminar analysis. Greater scatter is reported for the helium injection data, but a reduction in heat transfer did occur [11H].

A number of NACA reports, some recently declassified, dealt with mass transfer to turbulent boundary layers. In one, difficulty involving plugging of pores in the porous test section resulted in nonuniform injection of the cooling air. However, considerable reduction in heat transfer was still reported [3H]. Air injection at a Mach number of approximately 2 gave turbulent skin friction [17H, 19H, 24H] and heat-transfer results [4H, 17H, 19H] which are in good agreement with the mixing-length analysis developed by Rubesin. On the other hand, Mickley and Davis have obtained new data with air injection and they find considerably lower skin friction than predicted by Rubesin. They also conclude that the critical Reynolds number at the interface between the laminar sublayer and turbulent core increases with injection rate, a conclusion difficult to understand in view of the greater instability of the boundary layer with injection [12H]. A mixing-length analysis of heat transfer and skin friction for light-gas injection into a turbulent boundary layer on a flat plate has been advanced; for helium injection it underestimates the reduction of heat transfer found experimentally. Further, it indicates that no major change in recovery factor occurs [18H].

Surface melting: Two papers, one dealing with the melting of ice placed in a hot air stream [14H]; the other investigating using the melting of pyrex glass in the stagnation point of a blunt body at hypersonic flow for surface protection [21H]. Mass transfer into such hypersonic boundary layers may result in combustion of the injected material. This problem has been analyzed, and it is concluded that the mass-transfer process is still very effective and the major influence of combustion is to increase slightly the coolant mass requirement [8H, 10H].

Film cooling, wherein the coolant liquid or gas is injected through a discrete slot and flows along the surface to be protected, underwent an experimental study in which the development of the velocity profile was determined [2H].

The heat-transfer coefficients for laminar air flow over

ellipsoidal and disk-shaped surfaces are inferred from mass-transfer measurements made with napthalene models [9H, 23H]. For turbulent flow, measurements of the eddy diffusivity of mass and momentum are determined from the measured profiles, and it is reported that the diffusivity values are higher for mass transfer [5H].

Finally, the Couette flow model has been used to study the effect of suction and blowing on flow between two infinite parallel plates or in the annular space between two infinite cylinders with one wall held stationary while the other wall is moving [13H].

Change of Phase

Heat transfer involving a phase change: Topics included bubble dynamics, pool boiling, forced-convection boiling, condensation, and multiphase flow. Bubble growth rates were studied analytically under the assumption that the surface tension and the dynamic effects are unimportant as compared to the heat-transfer process [3J, 13J]. The resulting bubble size is predicted for a range of pressures, wall superheat values, and bulk-fluid temperatures [13J]. It is shown that these results also apply to the growth of a gas bubble in a supersaturated liquid [3J]. A check on these predictions is available in high-speed photographic studies of bubble growth on a nichrome wire [9J].

The influence of system pressure level on the nucleate film boiling of a number of organic liquids was studied. For a fixed heat flux it was found that the temperature difference between the wall and the saturation temperature decreased with increasing pressure; the correlation proposed by Rohsenow gave agreement with the data [21J]. From observations made on the transition from nucleate to film boiling with water it was inferred that film boiling is incipient when the average covered area of the heated surface is equal to one half the total area [8J]. Nucleate and film-boiling data on electrically heated probes placed in liquid helium have been published [12J].

Film-boiling performance of a number of liquids from vertical tubes has been measured, including liquid nitrogen and methanol. With the exception of the nitrogen, all of the experimental results were above the laminar prediction, and this is to be expected since calculated Reynolds numbers indicated that turbulent flow existed. The liquid nitrogen was in laminar motion and agrees with the laminar theory [16J].

A promising stability analysis leads to a prediction of the maximum and minimum heat fluxes in the nucleate and film-boiling regimes, respectively. Good agreement with available peak heat-flux data lends confidence to the prediction [25J].

Forced-convection-boiling heat transfer: The effect of adding small amounts of alcohol to the flowing water is to decrease bubble size and to improve the smoothness of the boiling process—of some importance in nucleate reactors where large fluctuations are undesirable [18J]. Using available experimental data, a simple equation which may be of value to designers of heat-exchanger equipment has been proposed for predicting forced-convection nucleate-boiling heat transfer [11J].

Film boiling of flowing subcooled liquid is analyzed and a prediction equation proposed. The analysis shows, and experimental data verify, that heat transfer is markedly increased by such subcooling [22J].

Burnout in forced-convection boiling has been experimentally studied in circular tubes [19J], rectangular channels [17J], and in a vortex tube [10J]. For the circular tube an upstream restriction was stabilizing, while other changes increased the instability and decreased the heat flux at burnout [19J]. The rectangular-channel investigation was conducted at 2000 psi for a number of length-to-diameter ratio channels; burnout results were equivalent to those found in circular geometries [17J]. Boiling data taken in a circular tube through which water flowed in a spiral or vortex motion, yielded the extraordinarily high heat flux at burnout of 50×10^6 Btu/hr ft^2 [10J].

Film condensation on horizontal, vertical, and inclined tubes: A theoretical analysis treats the situation where the thermal resistance at the interface between the liquid and vapor is appreciable, a condition which occurs when the system total pressures are low and small quantities of noncondensible gases are present [1J]. Films flowing down vertical tube were observed as to the character of the free surface (i.e., smooth or wavy), and data are presented for film thickness and shear stress as a function of flow Reynolds number [14J]. For such films, three flow types have been observed: laminar, wavy, and turbulent. A heat-transfer analysis is developed based on three observations and yields results in good agreement with measured heat-transfer values [4J].

The condensation of superheated Freon on a horizontal tube has been measured; an increase of superheat at constant pressure results in decreased tube-wall temperature and decreased heat transfer [2J]. An analysis for film condensation on inclined circular cylinders following the approach of Nusselt, gave values which were lower than found experimentally; this difference was ascribed to the rippling of the free surface in the experimental measurements [15J]. The influence of inert gases on the condensation processes has been investigated [20J]. Evaporation from thin liquid films including photographs has been quantitatively studied [5J].

Using new experimental data as a basis, the Lockhart-Martinelli pressure-drop correlation for two-phase flow has been extended to account for the effect of surface roughness [7J]. The concurrent flow of air, oil, and water in a 3-in. diam, 38-ft-long tube has been investigated and the resulting pressure drop is reported for a wide range of flow parameters [23J]. The flow through a pipe of a condensing vapor, under the restriction that the vapor is completely condensed at the exit, is treated by a simplified one-dimensional analysis [6J]. A graphical method for calculating heat and mass-transfer rates in condensation, cooling towers, wet and dry-bulb hygrometers has been outlined [24J].

Radiation

A problem in space propulsion is the storage of liquids at low temperatures in Dewar flasks. A study is reported [7K] in which the emissivities of metallic surfaces were measured between 76 K and 300 K. It is found that surface polishing may actually increase the emissivity and, at pressure levels as low as 10^{-6} mm Hg, surface contamination by residual gases must be considered. Two companion papers [17K, 21K] present experimental emissivity measurements of various high-temperature alloys and pure metals between 1000 F and 2000 F. Both total normal and total hemispherical emissivities were measured. Another investigation [16K] presents total emissivity values for similar metals up to 1100 F.

Spectral measurements of the reflectivity of evaporated aluminum and silver films are reported [9K]: An ingeneous multiple reflection system is utilized for greater accuracy. Both spectral and total emissivity measurements were made [2K] on 25 typical aircraft materials, and a complete discussion included of experimental techniques and errors. Two experimental procedures are described [3K] which were used to obtain total-absorptivity measurements for solar radiation on a class of porous materials.

One of the most difficult problems in heat transfer involves the radiation exchange between walls of a container and the enclosed gas. A method is reported [12K] for predicting such an exchange in enclosures where allowance is made for gas-temperature variation. Practical problems arise in furnaces, as in steelmaking, and are the main subject of study by the International Flame Research Foundation. Two papers [6K, 18K] describe the work of this foundation and summarize results. In the same area is the calculation of heat exchange by radiation in cooled combustion chambers [13K].

A model method for the determination of geometric factors in solid-to-solid radiation [20K] offers a comparison between experiment and theory. Problems of pyrometric techniques at low temperatures are discussed in a pair of papers [10K, 1K] where it is shown that optical pyrometry can be utilized in the temperature range 400–500 C. Another study [4K] describes a transistor self-balancing radiation pyrometer designed to measure surface temperatures as low as 150 C.

A study of pipes to transmit radiation in the far infrared has been made [15K]. Such a technique is useful when a radiation source must be located far from the input location of the radiation detector. Another paper [11K] treats the use of a capacitor microphone as a radiation detector. Among its advantages: It acts as its own telemetering device.

Measurement of intense beams of thermal radiation: A transducer is described [5K] which permits the direct recording of integrated thermal energy at levels up to 200 cal/cm²/sec with a system-time constant of 20 millisec. In the same high temperature and high heat-flux area, [19K] presents the design and construction of a black body which may be used up to 2700 K.

A calculation procedure to determine the emissivities of cylindrical black bodies is described [14K], and methods are presented [8K] for computing temperature distributions in glass sheets amid the complications of penetration of external radiation, emission and partial reabsorption of radiation, and multiple internal reflections.

Liquid Metals

Liquid metals are characterized by high thermal-conductivity values and low Prandtl numbers. For flow over external surfaces, the velocity boundary-layer thickness is much smaller than the thermal boundary-layer thickness and, consequently, the inviscid velocity distribution gives a good approximation to the actual velocity profile in so far as thermal behavior is concerned. Using this approach, the heat transfer for liquid metals flowing over single cylinders and flat plates, including the influence of heat generated in the fluid, has been determined. Both the isothermal boundary condition and the constant heat-rate boundary condition are treated [2L]. These solutions have been extended to liquid metal flow through tube banks where the potential flow field was first determined with an electrical analog [1L]. The comparison with experimental data is good at low Reynolds numbers; at high Reynolds numbers where the effects of turbulence—neglected in the analysis—become important, the predicted heat transfer is low. The long-term experimental study of mercury flowing across banks, at Brookhaven National Laboratory, is continuing and new results are available [4L].

The heat-transfer performance of liquid metals flowing turbulently in circular tubes has been re-evaluated, using the momentum analogy in conjunction with a simplified velocity profile. The analysis utilizes data from earlier investigations to specify the ratio of eddy diffusivity of heat to that for momentum [3L].

Measurement Techniques

A pneumatic probe for the measurement of gas temperatures [13M] was designed to have short response times and to operate at temperatures as high as 2000 C. When using radiation shields around thermocouples it is often necessary to know the temperature distribution in the shields in order to estimate temperature-measure-

ment errors. A recent study [1M] deals with the use of finite-difference techniques to determine these temperature patterns. The problem of the measurement of gas temperatures in shock waves is discussed [21M].

The dynamic thermocouple formed by the moving junctions of two dissimilar metals has been investigated [11M]. Another interesting thermocouple problem concerns the effect of interdiffusion between the two metals at the hot junction. It is predicted [22M] that a thermocouple in a temperature gradient of 10 C/cm may be in error from diffusion by as much as 1.3 C after operating for 100 days at a temperature of 1500 C.

A two-color pyrometric technique for temperature measurements in solar furnaces [3M] is usable in the temperature range of 1100 C to 3500 C. The method has a predicted uncertainty of 10 C and does not require the knowledge of the radiation properties of the surface being measured. In a small bead thermistor housed in a hypodermic needle [28M], the probe has a 95 per cent response time of 170 millisec and a thermal noise level of less than 2×10^{-4} C. Also using thermistors is a simple and rapid method for making surface temperature measurements, where accuracy requirements are not greater than 1 C [26M].

The heat-transfer specialist is familiar with the technique of replacing thermal resistances and capacitances with their electrical counterparts. It is illogically gratifying to discover that occasions exist when the converse is useful. As discussed in [17M], low-frequency automatic-control systems which have considerable difficulty with capacitor leakage and resulting instability can be improved by the substitution of thermal elements for electric elements.

An ingenious and simple electric analog for unsteady-state heat-conduction problems [9M] uses conducting paper, a dielectric sheet, and a metal foil, making possible an analog with distributed resistance and capacitance. Comparisons with a number of exact solutions show agreement within 10 per cent. Other analog studies include a reinvestigation of rubber-membrane theory [10M] and the use of electric analogs for transient axisymmetric heat-conduction problems [24M].

A large number of papers took up methods for the determination of thermal conductivities. A radiation-cooled bar which is heated electrically and whose face temperature indicates the thermal conductivity [20M], has served to measure the thermal conductivity of graphite at 2500 K. Two papers [27M, 4M] describe methods for measuring the thermal conductivity of liquids.

Deviations from one-dimensional heat flow in guarded hot plates have been investigated by conformal-mapping techniques [31M] resulting in expressions for error heat flows in test specimens. An inexpensive apparatus for rapid thermal-conductivity measurements of solids neat room temperature is described [12M], and a procedure to determine thermal conductivities of insulating materials over a wide range of temperature in a single test is reported [18M]. The last two of this series of papers deal with a method of measuring the thermal conductivity of granular materials [29M] and a simple multipurpose thermal comparitor suitable for measuring thermal conductivity, surface roughness, foil thickness, or surface deposits [23M].

The shock tube continues to be one of the most useful devices for investigating heat-transfer problems associated with high-speed flight. A method of producing high-velocity shocks by arc discharges is discussed [14M], and a calorimeter heat-transfer gage for shock-tube use is described [25M]. A shock-wave detector using a bolometer [5M] has high response speed and adequate sensitivity for the detection of weak shocks in low-density gases. The use of x-ray absorption to measure densities behind shocks with an accuracy of one per cent has been reported [15M].

Flow-visualization techniques applied to combustion problems are discussed in detail in [30M]. Conventional techniques become inadequate in low-density wind tunnels at static pressure levels below two mm of Hg. Two papers [19M, 8M] describe methods which may be used under these conditions.

A sensitive micromanometer for measuring pressure differences as low as 10^{-5} in. of water is reported [7M], and an instrument for air-velocity measurements in the range 0–4 ft/sec is described [16M]. The analysis and experimental evaluation of a probe for measuring stagnation pressure and velocity of a particle-laden gas are described in detail [6M], while an experimental method is presented for obtaining free-convection heat-transfer information for fluids whose physical properties are not known [2M].

Heat Transfer Applications

Heat Exchangers. An experimental study of laminar pressure drop and heat transfer in the shell side of cross-baffled heat exchangers has been reported [7N]. Two papers deal with unsteady-state conditions in exchangers. The first [1N] considers the dynamic response when there is a sudden change in the rate of heat generation. The other [2N] reports an investigation of the transient behavior of a two-fluid direct-transfer counterflow gas-turbine regenerator.

Finite-difference calculations for rotary regenerator performance are described [6N]. The final result is the exchanger effectiveness for typical ranges of the operating parameters. The stability of the flow through parallel passages, as influenced by mixing headers spaced at intervals in the flow direction, has been investigated [5N]. In a study [3N] of heat-exchanger optimization, where analytical methods which lend themselves to machine-computer use are described, general optimization equations are presented for counterflow, parallel flow, and single and double crossflow situations, and an example is given for the calculation of a minimum-volume exchanger.

At some loss to his dignity, it is often useful to treat man as a simple heat exchanger in environmental

studies. It has been shown [4N] that the large body of available calorimetric data on human heat exchange can be summarized by statistically derived empirical equations having five variables.

Aircraft, Missiles, and Satellites. A survey of heat-transfer problems connected with re-entry and with flight at extreme velocities was presented [8P, 10P]. More detailed studies on the motion of missiles and its effect on aerodynamic heating [1P] and on the temperature of the skin of the vehicle during the re-entry [2P, 7P, 9P] should help in the design of such craft. Aerodynamic heating can be minimized by a proper burning program for missiles as they traverse the earth's atmosphere [6P].

The designer is also interested in a shape for missiles which has a locally constant heat flux [3P]. In the development of space flight, one has to be concerned with the re-entry problem into the atmospheres of other planets [4P]. For experimental studies of unsteady temperature conditions in components of a high-velocity vehicle, aerodynamic heat simulators have been developed. Such a device, which generates a heat flux exceeding 1500 watt/cm^2 and which is uniform within 3 per cent over an area of one sq ft, is reported [5P].

Electronic Equipment. In the development of electronic equipment for high-speed vehicles, attention has to be focused on proper cooling because such equipment often has to operate in a high-temperature environment and because internal heat generation in the equipment causes more difficulties as the equipment becomes more compact. A collection of papers on such problems and on possible solutions is presented in [5Q]. Additional information is found in the other references listed under Electronic Equipment.

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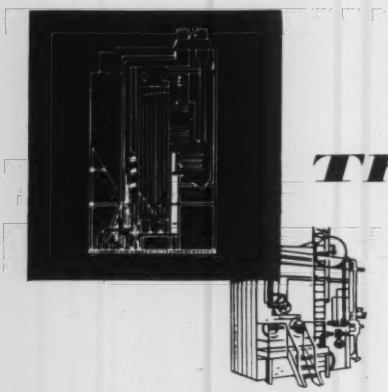


The ASME Boiler

How the Code Originated

By J. H. Harlow, Fellow ASME, Chief Mechanical Engineer,
Philadelphia Electric Company, Philadelphia, Pa.

IN THE YEARS prior to the preparation of the ASME Boiler Code in 1915, there was a great deal of confusion caused by each state going its own way in the regulation of boiler construction and installation. There were many serious explosions of a character we seldom hear of now. The confusion and the loss of life and property became literally unbearable. This was the compelling reason which brought the Code into existence.

Although there were a few attempts to use higher pressures, practically all of the boilers and engines operated prior to the beginning of the 19th century produced steam at atmospheric pressure or only 10 or 15 psi above atmospheric. Many of the engines such as those of Savery, Newcomen, Huygens, and others were atmospheric engines in which the piston was arranged to be raised by a weight and the space under it was filled with steam. When the end of the stroke was reached a spray of water was injected into the cylinder. This "collapsed" the steam and atmospheric pressure drove the piston into the cylinder.

However, with the invention of the condenser and engine of James Watt the move to higher pressures began, and about the year 1800, pressures of 50 psi became common on steamboats. One of the early boilers of this pressure range was a sectional water-tube boiler built in 1804 by John Stevens. Inspection requirements were not understood or were neglected and operators were unthinking or even deliberately careless to the extent of overloading safety valves. In addition, there was a lack of design knowledge, and as a consequence boiler explosions and resultant losses of life and property became one of the engineering problems of the time.

One of the first recorded public efforts to control this situation was an action of the Council of the City of Philadelphia, in 1817, in which it was requested that the Legislature of the Commonwealth of Pennsylvania prepare a law requiring tests of the strength of boilers, the use of properly placed safety valves, and monthly inspections. A similar action in Great Britain at about the same time recommended that wrought iron be used, that hemispherical or segmental heads be used in cylindrical boilers, that two safety valves be used, and that the operating pressure be limited to one third of the test pressure at inspection.

Based on two papers presented at a meeting of the Process and Metals Division of the Metropolitan Section, New York, N. Y., January 26, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Work at the Franklin Institute

One of the first scientifically conducted approaches to the problem was undertaken by the Franklin Institute in 1826. Many strange theories were being advanced at that time. There was one regarding the formation and explosion of hydrogen and one which supposed that water under certain conditions would flash into steam at pressures higher than that corresponding to the temperature of the water, and others of like fantastic nature. So many reasons were suggested and so many explosions were occurring that in May, 1830, a committee of the Institute was formed to determine if it was desirable "to institute an investigation into the probable causes of these accidents and the proper remedy to be applied to prevent their occurrence."

The committee comprised some famous names such as Keating, Fox, Lukens, and Baldwin. It must have acted promptly, for within a month the committee reported that, in its opinion, steam power was here to stay; that improper design, operation, and care were responsible for the explosions; that the causes of the accidents could be eliminated by suitably applied regulations; and that there should be power in the community to cause the regulations to be applied. The report, also, cautioned against the overzealous application of this political power.

The result was the instigation of a truly objective approach to the problem which took a number of directions. First, a small glass boiler and a small iron boiler with glass windows were built. These were used to study the nature of boiling, the proper location of fusible plugs, the effect of water contacting overheated plate, the effect of scale, the behavior of safety valves, the saturation temperature of water at various pressures, and similar matters. Second, as many people as possible

and Pressure Vessel Code

.....is a notable example of service by the Society to industry and the public. The Code Committee was originally formed by the Society to prepare construction requirements which would result in safe steam boilers for public use. The function has been extended to the allied field of unfired pressure vessels. The code is now legally accepted in 37 states, all of Canada and many municipalities.

who had experienced and lived through boiler explosions were interviewed and available reports were studied.

The committee then discussed the causes of boiler explosions, listing them under five headings: (*a*) Undue pressure under gradual increase; (*b*) presence of unduly heated metal; (*c*) defects in the construction of the boiler or appendages; (*d*) carelessness or ignorance of those entrusted with management of steam engines; (*e*) collapse of boiler or flue by rarification within.

Then the committee proposed and produced data on the strength of materials used in boiler construction such as copper and iron. Tests on copper were made at room temperatures and at temperatures as high as 1000 F, and wrought-iron tests were made at temperatures as high as 1300 F. Some of the results may be of interest. Copper at room temperature was tested at about 33,000 psi and 11,000 psi at 1000 F. Wrought iron gave values of about 60,000 at room temperature and 19,000 at 1300 F. Data were also produced on elongation, reduction of area, and elastic limits.

The work of the Franklin Institute resulted in a Federal Law in 1833 pertaining to inspection of boilers on ships and in the Steamboat Act of 1852. In 1942 this activity was transferred to the U.S. Coast Guard.

Insurance Companies

In 1866, The Hartford Steam Boiler Inspection and Insurance Company was founded for the purposes described in its name. It began almost at once to publish the *Locomotive*, containing many discussions of the problems of safety and design in boilers. And quite early it published "The Boiler Book" containing many basic rules for design.

The next company to organize for the purpose of insurance and inspection was the predecessor to the present Fidelity & Casualty Insurance Company, in 1876.

Since then, many other outstanding and well-known casualty insurance companies have been formed.

Early Legislation

About 1850 boilers began to be used more and more on land, probably because of the limited number of possible water-wheel sites. With this and the increased level of steam pressures, boiler explosions almost became the scandal of the day. Probably the most costly boiler accident of all time, however, was on the ship *Sultana* which, on April 27, 1865, was returning about 2000 Federal soldiers from a prison camp in Vicksburg. As a result of a boiler failure, 1500 persons lost their lives and the vessel was destroyed.

Each year the number of boiler explosions increased. One of the most significant in causing formal action occurred in Brockton, Mass., where the boilers in a shoe factory exploded on March 10, 1905, killing 58 persons, injuring 117, and resulting in property loss including claims of over $500,000.

Between 1850 and 1905 many cities and states recognized the problem and took more or less effective action. Laws were passed in New York (1859), Chicago (1867), and Detroit (1889). In 1888 there is a report of the Chief Inspector for St. Louis calling a meeting of State and City Inspectors to discuss these problems.

At the same time, the American Boiler Manufacturers Association was taking cognizance of the problem and, in 1889, began work toward raising the standard of boiler manufacture.

Following the explosion at Brockton and another at Lynn, Mass., in December, 1906, with similar loss, things began to happen more rapidly. On May 29, 1907, the Governor of Massachusetts approved the first state Boiler Law. This law included provision for a five-man Board of Boiler Rules. The Board was appointed on July 5, 1907, and on August 30, 1907, had prepared its first set of regulations, comprising but three pages. More and more rules continued to be developed and in early 1909 the regulations were ready for public hearing.

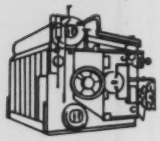
In 1911 Ohio prepared a law and regulations and other states soon joined the parade. All laws had differences and the confusion was already beginning to be felt.

ASME Activity

In 1911, E. D. Meier, president of the Heine Boiler Company, was elected president of ASME. He was extremely conscious of the imminent chaotic situation through the problems of his Company and through his official positions in ABMA.

On September 15, 1911, Col. Meier asked the Council of ASME to approve the appointment of a committee to formulate standard specifications for the construction of steam boilers and other pressure vessels. This request was approved and thus began the ASME Boiler and Pressure Vessel Code activity.

With C. W. Obert as Secretary, the Committee worked until a preliminary report and set of rules was offered in 1913, consisting of 230 pages. Much opposition appeared. In September, 1914, public hearings were held and in November, 1914, a third draft was prepared. In December, 1914, work was begun on the draft of the final report which was submitted to the ASME Council early in 1915. The Council, at its meeting on March 12,



The ASME Boiler and Pressure Vessel Code

1915, adopted the ASME Boiler Code as an official Society document.

Activity Outside the U. S.

During this time there were frequent and often disastrous explosions in England and on the Continent. Studies were undertaken to find causes and to prepare rules for safe construction. Insurance and inspection procedures were established, and codes were prepared and adopted by the several nations.

Since World War II there has been an attempt to unify boiler codes on a world-wide basis through the International Organization for Standardization. The ASME Boiler and Pressure Vessel Committee has been active in this endeavor.

Expansion of the Code

The original ASME Code contained rules only for the construction and care of boilers made of riveted plate. Over the years it has been greatly enlarged, so that it now includes, in addition, rules for pressure-vessel construction; rules for welding; material specifications, both ferrous and nonferrous; stress allowances; and so forth. In the Code-making activities can be found many of the top metallurgists, top welding engineers, and top designers in the country. The utilities have also contributed greatly and have always been represented on the main committee by at least one man.

Acknowledgment

The historical background in this article is based largely on the study by Arthur M. Greene, Jr., "The ASME Boiler Code," MECHANICAL ENGINEERING, vol. 74, 1952, pp. 555–562, and subsequent issues.

The Code in Operation

By E. M. Kloeblen, Mem. ASME, Assistant Manager, Safety Codes Department, Linde Company Division of Union Carbide Corporation, New York, N.Y.

The ASME Boiler and Pressure Vessel Code is a construction code, not a handbook, for use by experienced design engineers, providing minimum standards as they become available and are accepted by the Code Committee. Specific designs are not considered by the committee, but are approved in the states by insurance companies and in the provinces of Canada by the provincial boiler inspector. In addition to the states, cities, and provinces which have adopted the code in whole or in part, it is also a part of many federal government regulations. It is incorporated in the rules for the construction of vessels for use in transportation, such as the Interstate Commerce Commission Specifications for Cargo Tanks and Portable Tank Containers, Coast Guard regulations, and as a part of many military specifications.

Through the years, a complex co-operative structure has developed. Essentially, ASME formulates and interprets rules for the construction of boilers and pressure vessels which industry applies, and the governmental agencies enforce them in co-operation with the insurance companies. The functions of various groups will be described briefly.

ASME Boiler and Pressure Vessel Committee

The Main Committee's function is to establish rules of safety governing the design, the fabrication, and the inspection during construction of boilers and unfired pressure vessles, and to interpret these rules when questions arise regarding their intent. In formulating the rules, the committee considers the needs of users, manufacturers, and inspectors of pressure vessels. There are 23 members having experience and background in the fields of manufacture and use of the products covered by the rules as well as other related fields.

In fulfilling its responsibilities, the committee meets six times a year—five times in New York City, and once at some other location where the problem of building or using boilers and pressure vessels is of much concern.

Each state and municipality in the United States and each province in the Dominion of Canada that adopts or accepts one or more sections of the Boiler and Pressure Vessel Code is invited to appoint a representative to act on the Conference Committee, which has limited participation in the voting of the Main Committee and provides contact with local problems. At present there are 56 members.

There are 16 subcommittees of the Main Committee, 10 special committees, and numerous task groups of these various committees which complete the organization responsible for the Boiler and Pressure Vessel Code and involve approximately 300 engineers.

When a question or request for interpretation of the Code is submitted to the Secretary, the matter is placed before the subcommittee(s) involved, who act upon it by correspondence or in a meeting. Depending on the nature of the reply, the subcommittee reports to the Main Committee in the form of a letter reply, an interpretation, a Special Ruling, or Revision to the Code. Interim revisions are made semiannually in the form of addenda to the triennial publications of the complete Code. In this way, provision is made for including the most advanced technology as rapidly as it can be made available.

After the Cases—as Special Rulings and interpretations are called—have been acted upon by the Main Committee, and have been approved by the ASME Board on Codes and Standards, authorized by the Council of the Society to act upon them, they are also published in MECHANICAL ENGINEERING and may be used. Since all states do not automatically accept these actions by ASME, it is necessary to check the jurisdiction within which the boiler or pressure vessel will be installed regarding acceptance of these modifications.

As need arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published in MECHANICAL ENGINEERING as proposed addenda to the Code. If no criticism or comment is received within a month they are acted upon and, as finally approved by the ASME Board on Codes and Standards and formally adopted by the Council, they are included in an addenda sheet which when published becomes an official part of the Code.

The Boiler and Pressure Vessel Committee does not have funds at its disposal for conducting research and engineering test work to improve the rules of the Code. However, there are several organizations which develop such information that may be used by the Committee.

Research and Application

For many years the advancement of the Code incorporating new materials, design, and fabrication rules resulted mainly from research and development within industry. This is not as prevalent as in past years, although in some cases special rulings are issued on the basis of laboratory test data submitted by the manufacturer and witnessed by Committee members.

The American Society for Testing Materials. ASTM prepares specifications for the procurement of materials which are reviewed and, if approved, become part of Section II of the Code, entitled "Material Specifications."

American Standards Association. The ASA Standard for Flanges and Standards for Bolts and Nuts are among the ASA Standards either referred to in the Code or reproduced there.

The Welding Research Council. The Council and its Pressure Vessel Research Committee develop information for the advancement of welding and pressure-vessel design through sponsoring and supervising test programs and publicizing the results. This organization is supported financially by industry, the various technical associations including ASME, and government agencies, including the Armed Forces where their interest is involved.

The ASTM-ASME Joint Committee on the Effect of Temperature on Metals. This committee is subdivided into a series of "panels" which supervise research and testing projects within their fields of interest. A particular project is customarily given financial support by the interested industry group.

Inspection

Most of the state laws require inspection by licensed inspectors who may be in the employ of the state or of a casualty insurance company which is licensed to do business within the state. Several organizations are interested in the inspection procedure, the insurance problems, and the adoption of adequate legislation.

National Board of Boiler and Pressure Vessel Inspectors. Uniform administration and application of the Code is the purpose of this organization. The membership consists of the Chief Boiler Inspector or other legally constituted official of states, cities, and provinces adopting one or more sections of the ASME Boiler and Pressure Vessel Code.

An important function of this organization is to provide a central file and to circulate copies to the local inspectors of the Manufacturers Data Report for boilers and pressure vessels manufactured to the ASME Code. Commissions are provided for inspectors employed by states, cities, or insurance companies upon their satisfactory completion of a standard examination which is prepared by the National Board and used throughout the country.

This particular action provides for uniform enforcement in the construction and periodic inspection of pressure vessels. Through the Board's *Bulletin*, inspectors are acquainted with the latest information on matters concerning the National Board, the ASME Boiler and Pressure Vessel Code, and similar items. The National Board Inspection Code provides a uniform set of rules for the inspection and repair of pressure vessels in service which has been incorporated as part of the regulations of many states. The inspection code includes rules for repairs by welding which permit field repairs to be safely made.

The National Board sponsors work on the flow testing of safety valves, establishes standards for flow-test equipment, and publishes the capacities for the valves tested. As a result of experimental work on blow-off tanks, their blow-off-tank rules have been accepted as standard in many locations.

National Bureau of Casualty and Insurance Underwriters. This organization of the insurance companies publishes a "Synopsis of Boiler and Pressure Vessel Laws, Rules, and Regulations" which summarizes local regulations and is revised and kept up to date.

The insurance companies themselves through their engineering and inspection organizations provide for review of specific designs and furnish the inspection and other assistance necessary to proper application of the Code.

Uniform Boiler and Pressure Vessel Laws Society. This Society played an important part in obtaining acceptance of the Boiler and Pressure Vessel Code when it was first written, and continues to sponsor its adoption where there are no laws, or where the laws vary from those generally accepted as standard. A "Model Boiler Law" and "Model Boiler and Pressure Vessel Law" are maintained for adoption by the states. An annual *Data Sheet* keeps members acquainted with the regions where the Code has been accepted.

The Future

A hint of the future of the Code is provided by a list of some of the special committees. These now take cognizance of nondestructive testing, design and fabrication to avoid brittle fracture, stress problems, nuclear applications, and special jacketed vessels.

For a still further look into the future consider that metals are the materials of construction for pressure vessels in the Code. But there are a number of nonmetallic materials being used in structures today which may find their way into pressure-vessel design, such as prestressed concrete, impregnated graphite, and glass-fiber-reinforced plastics.

As far as design and fabrication are concerned, the Code will keep in step with progress through the research projects of the Pressure Vessel Research Committee, the Joint Committee on the Effects of Temperature on Metals, and industry research.

A full knowledge of the operation of this activity of the ASME is necessary to its future development. Its continued effective service to industry depends on the wide and varied co-operation that has grown over the years, and a broadening of this co-operation as the need arises.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD

Workers on incentive production do not have to wait for work with the Singer conveyer system. Eight individual conveyers moving at 6 to 40 fpm in five levels throughout the plant are co-ordinated from a single control panel. Up to four hours of storage are provided.

New Blood With a Conveyer

ALTHOUGH nearly all of the jinrikishas in use in the Orient at one time were made in Burlington, N. J., most U. S. manufacturing has been aimed for the domestic market first, with foreign markets a secondary consideration. The Singer sewing machine was a notable exception. Its manufacturers took a global view even a half century ago.

In the past decade, the Singer Manufacturing Company's U. S. operations have fallen on hard times, with a triple threat to their continuation—emancipation, industrialization, and what *Fortune* terms "hardening of the assets."

The emancipation took place with American women who just don't do as much of their own sewing as they used to. The industrialization has taken place in the Orient, particularly India and Japan, and Japan has become such a tough competitor in the U. S. that all other American sewing-machine manufacturers have gone out of business. The "hardening of the assets" has resulted from a 100-yr conservative accumulation of more assets than are being profitably employed.

One of these "assets" is a 3,000,000-sq-ft plant at Elizabethport, N. J., now so much too large and too old that $1\frac{1}{2}$-million sq ft are up for sale and operations are being more efficiently consolidated in the remaining half. First step is the development of a complete "packaged" plant for the production and assembly of one model of sewing machine and the production of parts for two other models assembled elsewhere.

To cut manufacturing costs to a competitive level, $1\frac{1}{2}$ miles of conveyer in eight closed loops with four automatic transfers have been installed by Mechanical Handling Systems, Inc., of Clark, N. J., at a cost of $5 million. Materials for the fully produced model enter the plant as blanks and leave as finished machines. Traffic flow on the conveyer was planned by Mechanical Handling and Singer engineers to permit the use of an incentive-wage system and to provide for 1-shift operation in some areas and 2 shifts in others.

By contract with the union, the company agreed that the conveyer would always have work waiting for each employee, and that there would be an empty space available to receive finished work for transportation along the line. Since each worker sets his own pace, and to minimize work stoppage by a failure in any part of the plant, up to four hours of storage are provided on the conveyer and it is not necessary to maintain a sequence. Any stage of work can be hung on at any time, since pickoff for such automatic operations as degreasing or painting is controlled by projecting fingers on the racks.

Since parts are light enough to be carried easily, unconveyerized subassembly lines could be integrated into the flow pattern. At one point there is a cross flow where parts are passed by hand to five separate operations before being returned to the conveyer loop as it doubles back on the opposite side of the work area.

One of the greatest production economies resulted from installation of a completely automatic $600,000 electrostatic painting operation which can handle various sizes of parts (at different times) at a rate of 6 to 1500 units per min.

Manual assembly and adjusting stations also feed to the conveyer

Painting is entirely automatic. The conveyer carries parts past electrostatic painting machines.

Although final assembly is primarily manual, set screws, center screws, and shoes are automatically installed in the head by machine

Here, the conveyer travels in a 4-ft-ID semicircle while a disk whirling at 3600-rpm centrifuges paint toward the parts in a very fine mist. A hydraulically operated reciprocating shaft moves the disk up and down through 10 to 12 complete strokes per min. Grounding the conveyer to get a positive charge and providing a 90,000-volt low-wattage current for a negative charge on the disk insures the travel and clinging of every particle of the paint to the surface of the part.

There is no waste and, provided the part has no areas in its geometry that will cancel out the electrostatic attraction, the distribution of paint is uniform. A finish thickness of three double coats can be accurately controlled to provide a 5 $^{3}/_{4}$ mills net thickness when the paint is dry.

No mechanical agitation of the paint is required once it is in the system. Paint temperature is more critical than room temperature and is maintained at 105 to 110 F to keep it above ambient, even during the summer. After receiving two coats of primer, parts are baked for 30 min at 185 F and cooled, then sprayed for a third time with two final coats of enamel and baked again for 30 min at 325 F.

The new facilities have turned an old inefficient operation, scattered among several multistory buildings, into a closely integrated 180,000-sq-ft plant designed to employ 750 people working two shifts to produce 5000 complete machines a week and an additional 5000 sets of parts for the other two models to be assembled at a Singer plant in Anderson, S. C.

Composition of Lubricating Oils

A METHOD of determining the composition of lubricating and other oil stocks in terms of different types of molecular structure has been developed by Gulf Research & Development Company. The result of a fundamental-research program, it will enable process and product engineers and chemists to correlate the performance of these oils with hydrocarbon type and the distribution of hydrocarbon types with respect to molecular weight.

In order to develop the method for the determination of hydrocarbon types, it was first necessary to recognize the various hydrocarbon types contributing to a mass spectral pattern. In a mass spectrometer, electron bombardment of the hydrocarbon sample produces numerous charged fragments of different masses by breaking C-H and C-C bonds. The mass spectrometer then separates these fragments according to their mass distribution and measures the number of individual fragments in terms of ion currents.

Gulf's study showed that the sum of the ion currents is a linear function of the molecular weight for each homologous series. With this basic generalization established, it was then possible to calculate from mass spectral data the composition of a lubricating oil in terms of alkanes, noncondensed cycloalkanes, condensed cycloalkanes and the number of rings per molecule, alkyl benzenes, and condensed aromatics up to and including three rings per molecule.

Data in terms of these hydrocarbon types provide a wealth of information to the process and product engineers and chemists which has not been available heretofore. It is now possible to correlate on a much firmer basis the physical properties of lubricating oils and their engine performance in terms of the distribution of the various types of hydrocarbons.

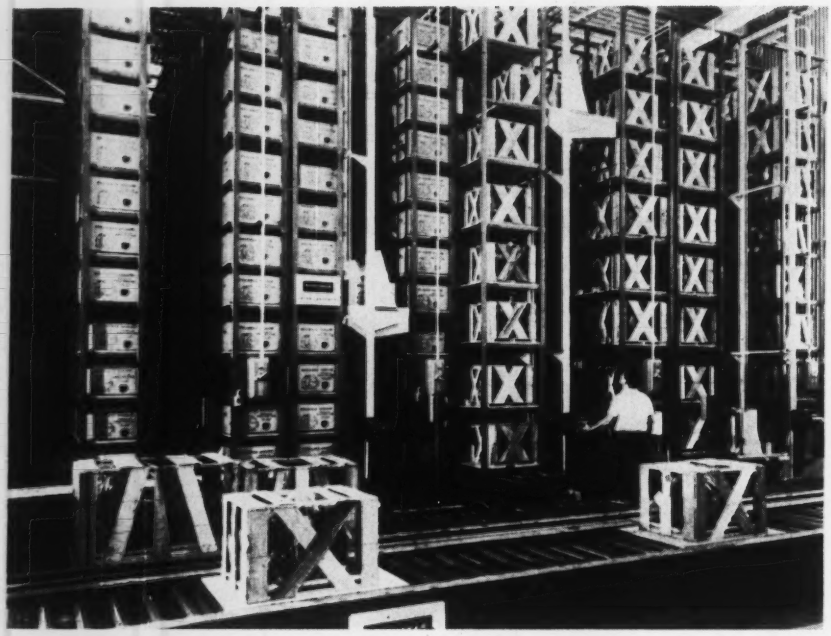
The establishment of how different molecular types affect performance is, of course, the first step in leading to tailor-made oils, that is, oils containing predetermined concentrations of definite type in order to have desired, preset performance characteristics.

A portion of the work which led to obtaining the information on the composition of lubricating oils is described by G. F. Crable and N. D. Coggeshall in a paper, "Application of Total Ionization Principles to Mass Spectrometric Analysis," *Analytical Chemistry*, vol. 30, March, 1958, pp. 310–313.

Stainless-Steel Mufflers

TYPES 430, 304, and 310 stainless-steel mufflers in both conventional and new designs are being tested in a variety of automobiles. They would replace those made of mild steel which last 9 months to $1^{1}/_{2}$ yr, on the average, or about 15,000 miles under the corrosive attack of the sulfuric and hydrochloric acids which modern fuels pass into the exhaust system.

Test surveys made in the co-operative program of Allegheny Ludlum Steel Corporation and a number of muffler manufacturers reveal that short-run, stop-and-start driving is hardest on mufflers. One reason is that corrosion occurs when the muffler operates in the 180 to 200-F range. With continuous or high-speed driving, temperatures go up to 850 or even 1100 F and the corrosive condensates are evaporated and blown out through the tailpipe.



Loads up to 3500 lb can be delivered to or from any of 4800 storage compartments by push button in a new "two-way Retriever" system

Automatic Storage and Handling

A NEW push-key storage and handling system delivering loads of up to 3500 lb to or from any of 4800 storage compartments at an average of a load a minute, is announced by Triax Equipment, Cleveland, Ohio.

The new "two-way Retriever" system transports these loads to or from a central loading dock entirely by electrical control, and requires less than one half the floor area used by conventional storage methods.

It can be enlarged to provide selective delivery of any desired volume of material. An electrically operated traveling carrier moves horizontally along an aisle, then vertically to deposit or remove a load from tiers of compartments.

It can load or unload from openings on both sides of narrow aisles. A push-key panel at the end of each aisle provides for selectivity in loading or unloading specific compartments.

At the end of the aisles, loads are transferred to or from roller conveyers by mechanical means, for delivery to the loading dock or to the Retriever unit for storage.

Aisles which are 30 in. wide are lined with storage compartments to a height of just under 21 ft. The longest aisles are 150 ft in length and 42 in. wide. Each has 1008 compartments, extending 3 ft back from the aisle and approximately 2 ft at the opening. Vertically, the compartments are eight high.

Two 110-ft aisles contain 1392 compartments each, for 12-high stacking. The compartments extend 24 in. back from the aisles and are 18 in. at the opening.

Because loads are stocked above normal heights and the need for wide aisles is eliminated, 4800 storage compartments require only 5005 sq ft of floor space, including the operator's area and the conveyer system for transfer of loads to or from the central loading dock.

One man can handle the entire system without touching the loads involved, and extension of this one-man push-button control to a large storage area is merely a matter of adding more units to the system as desired.

Gyro-Glide monorail trains would use automobile freeways as existing rights of way for operation

Monorail Rapid Transit

GYRO-GLIDE monorail trains have been designed by Northrop Corporation, Hawthorne, Calif., to fit the rapid-transit needs of metropolitan areas.

Preliminary design of a system for a 1-mile link between downtown Seattle, Wash., and that city's Century-21 Exposition, which opens in 1961, is complete and engineering and production schedules for Seattle have been established pending a contract award.

Gyro-Glide could make use of the freeways and other existing rights of way.

It uses a unique propulsion and gyro-stabilization unit and extremely lightweight airframe-type construction.

The propulsion unit requires no trolley or third rail between stations. A 1000-lb inertial flywheel, set in motion by a station power source, whirls at speeds up

to 4400 rpm, turning a generator which provides current for the traction motors until the next station stop. On long runs, the flywheel can pick up new energy from sections of powered rail along the route without stopping. While the train is in motion, the flywheel also acts as a gyroscope to resist swaying. Weight of a four-car Gyro-Glide train is approximately 114,000 lb fully loaded—about one fourth the weight of conventional trains.

Cost of the overhead track and support structure would range between $1 and $2 million per mile, depending on location of routes and the number of station platforms required. Gyro-Glide cars would cost about $100,000 apiece when ordered in quantity.

Northrop would act as project manager for an entire transit-system "package" including trains, track, support structures, stations, and maintenance equipment.

In the current design, each 52-ft-long, 10-ft-OD car would have seats for 64 passengers. This capacity can be changed by design modification to meet the needs of various transit systems. Number of cars per train can also be varied according to need.

Top design speed is 150 mph, but actual operating speed in a transit system would probably be about 60-mph peak on a 1-mile run. For a long run between stations, top speed of about 100 mph is considered desirable.

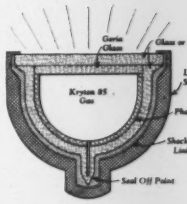
The gyro-power unit is manufactured by the Oerlikon Company of Switzerland and is in use on buses and mine cars in Europe.

Automatic Check Reader

ELECTRONIC EQUIPMENT that can "read" magnetic-ink characters imprinted on paper checks and transmit the information instantly into data-processing systems for automatic sorting and accounting has been demonstrated by IBM's Product Development Laboratory.

The main elements of this Series 1200 Character Sensing Equipment can read and act upon numbers and symbols which are inscribed in magnetic ink at the bottom of checks, deposit slips, and other bank forms. Easily readable by eye as well as by machine, the magnetic-ink characters have been specially styled and standardized under an extensive program sponsored by the American Bankers Association to be adaptable to equipment in all parts of the country.

There are 12 billion checks a year written now and it is estimated that the total will increase to 20 billion by 1963. Sorting and accounting for these checks are a major commercial bottleneck. Four basic pieces of equipment are used: (*a*) A Proof Inscriber which proves, lists, distributes, and endorses checks while automatically imprinting the documents with magnetic-ink characters for compatibility with the rest of the equipment; (*b*) a Sorter-Reader which automatically sequences and arranges 54,000 checks per hr, senses the magnetic-ink information and feeds it into other segments of the data-processing system; (*c*) a companion Sorter-Reader Control acts as the buffer for feeding information from the sensing unit into computers or punched-card accounting devices; (*d*) a Utility Inscriber which is an electric typewriter for quick imprinting in magnetic ink of damaged or substitute documents for system compatibility.



A cup light source using radioactive krypton 85 to activate a phosphor

Radioisotope Light Sources

Several types of light sources, based on the excitation of a phosphor by radioactive gases—krypton 85 or tritium—have been developed by the U. K. Atomic Energy Research Establishment at Harwell, England, according to an article by E. J. Wilson and J. D. H. Hughes of AERE in the British journal, *Engineering*.

Although there are many hundreds of phosphors, the most efficient for this purpose are those of zinc sulfide and cadmium sulfide.

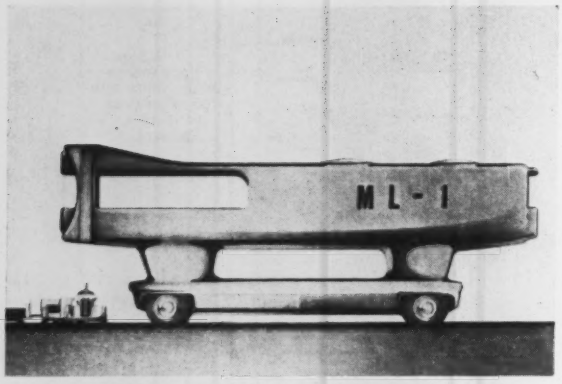
The radioisotopes used must have low toxicity, high energy, low cost, and ready availability. Gamma rays must be absent and there should be no undesirable by-products. Krypton 85 is the most desirable, since it is an unreactive gas which is not retained in the body for any length of time if it is inhaled in the event of accidental or malicious breakage. The small amount of gamma radiation present is not harmful when small quantities are used.

Tritium is useful, but comparatively expensive and somewhat toxic. There is no gamma hazard, so little shielding is necessary. However, plastics cannot be used for containment as tritium will diffuse through them by exchanging with the hydrogen atoms in the molecules.

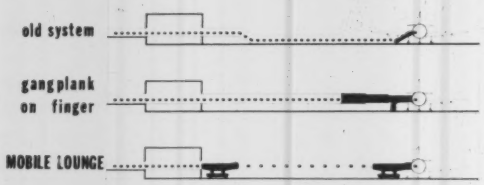
A spark-free source of illumination is provided by the radioisotope light sources where there might be an explosion hazard. The light sources are portable, absolutely self-contained, and unfailing, requiring no outside source of power. They will be particularly useful for direction indicators, exit signs, and various other types of markers.

The brightest source produced so far has an 8-in-diam lens and produces a more or less parallel beam of light of 2000 to 3000 microlamberts intensity. This is visible for more than a half mile in the dark, and provides enough light to enable newsprint to be read when held 3 or 4 ft from the light. One curie of krypton 85 is used. More light could be produced with higher activities, but heavy shielding would be required.

Checks are automatically sorted, posted, and otherwise processed with a new IBM system



PASSENGER MOVEMENT - TERMINAL TO PLANE



Passengers would board jets without climbing stairs in a mobile departure lounge driven to the aircraft

Mobile Departure Lounge

A MOBILE departure lounge will be used to transfer passengers to jet aircraft at the Washington International Airport now under construction at Chantilly, Va. This is a large vehicle which will stand on cushioned stilts and wheels. Measuring about 15 by 60 ft, it will comfortably accommodate approximately 75 passengers at the second-floor level. The passenger will step directly from the terminal building, through a "gateway" and into a "docked" mobile lounge.

At the appointed time the mobile lounge will be towed from the terminal building to the waiting aircraft. This can be parked at any distance from the terminal building to cut down expensive jet taxiing time. The lounge will attach to the aircraft doorway, and passengers can walk through and take their seats without ever having climbed or descended a single step.

5000-Watt Thermoelectric Generators

A 5000-WATT thermoelectric generator will be built by Carrier Corporation for the U. S. Navy Bureau of Ships for full operation within a year. The unit will be 15 to 20 times more powerful than experimental devices developed to date.

"Because it is potentially noiseless and vibration-free, this could become a vital element in our defense programs," according to J. F. Downie Smith, Mem. ASME, vice-president in charge of Carrier's central Research and Development Division. The lack of moving parts makes thermoelectric generators difficult to detect.

"In the future," Dr. Smith said, "these devices will have a wide variety of uses. Thermoelectricity is an obvious source of power in those parts of the world where conventional methods are not feasible. This technique can also be used for radio transmission and reception in areas where no current is available and when batteries are impractical."

These unique generators which require only heat to produce electricity, could be powered by natural heat from the sun or even heat escaping from industrial chimney stacks, which currently is wasted.

"Thermoelectric generators in the foreseeable future will provide stand-by emergency service when other power equipment is out of order. This applies to smaller units for residences as well as larger sizes for commercial power plants. During the next decade their capacity undoubtedly will be greatly increased," he added.

Carrier Corporation has conducted and sponsored basic research in this field for some years, and is also engaged in studies of similar thermoelectric mechanisms which transform electricity directly into heating or cooling without any moving parts.

Westinghouse Electric Corporation has received a similar contract.

Construction of the generator, Westinghouse officials said, is the first step in solving material-selection, fabrication, assembly, and operating and control problems of a large-scale thermoelectric power plant.

The heat source to power the new thermoelectric generator will be diesel oil or other fuel readily available to the Navy.

Thermoelectric power generation requires that a difference in temperature be maintained across the thermoelectric materials which, when heated, produce electricity. The cool side of the Westinghouse generator will be maintained by cooling with water. Ordinary sea water will be used directly, if possible, although fresh water, cooled by sea water in a heat exchanger, will be used if necessary.

The electrical output of the new generator will be such that it will operate existing Navy electrical equipment. The generator will operate with maximum quietness and will be designed for maximum shock and vibration resistance.

The utmost in flexibility will be built into the thermoelectric power plant. Although intended to be the small-scale prototype of a shipboard installation, it may be used directly as a movable or portable power source.

The 5-kw generator will be designed and built by Westinghouse primarily in its new central engineering laboratories.

Within the foreseeable future thermoelectric generators will operate with an efficiency as high as 35 per cent, it was predicted by Clarence Zener, director of the Westinghouse Research Laboratories.

Dr. Zener said that this top efficiency from a thermoelectric generator would be obtained by carefully selecting those materials which give maximum thermoelectric performance within the band of temperatures where they operate best. These materials then would be "cascaded" one after the other into three stages to cover a temperature range from about 3500 F down to room temperature.

Each stage of such a cascaded thermoelectric generator would accept the "waste" heat discharged to it by the stage ahead. Therefore, the over-all efficiency of the three stages would be greater than that of any single stage.

Nuclear Briefs

▶ Canadian Reactor for Fuel-Physics Studies

A NEW low-powered nuclear reactor designed specifically for testing fuel arrangements in large power reactors is to be built at the research center of Atomic Energy of Canada, Ltd., near Chalk River, Ontario. The new 100-watt reactor, known as ZED-2, will be moderated with heavy water, and early experiments will use bundles of uranium-oxide rods of the type planned for use in large atomic power plants such as the proposed 200-mw CANDU.

Basic design features for the $3-million plant were developed at Chalk River. Detailed plant design, reactor engineering, and construction will be by Foster Wheeler Limited, the Canadian subsidiary of Foster Wheeler Corporation, New York, N. Y.

▶ New Production Reactor at Hanford

The Atomic Energy Commission has entered into a cost-plus-fixed-fee contract with Kaiser Engineers, Division of Henry J. Kaiser Company, Oakland, Calif., for construction of the New Production Reactor at Hanford Works, Richland, Wash., scheduled for initial operation in October, 1962.

Kaiser's contract will be for about $100 million of the $145-million total cost of the graphite-moderated reactor which will be for the production of plutonium. Electric-power generating equipment can be added at a later date if desired.

Design and engineering work on the reactor is by General Electric Company, the AEC's prime operating contractor at Hanford. Burns and Roe, New York City, are supplying architect-engineering services for the heat-dissipation and supporting facilities.

New Oxygen Steelmaking Process

A SWEDISH oxygen steelmaking process, which has attracted world-wide metallurgical interest because of its high operating efficiency and low installation cost, has been brought to the United States and Canada by Dravo Corporation. The company has acquired exclusive marketing, plant-design, and construction rights for the United States and Canada according to an announcement by Carl B. Jansen, Mem. ASME, and president of Dravo.

Developed by Stora Kopparbergs Bergslags AB, giant 600-yr-old Swedish producer of steel, pulp, newsprint, and chemicals, the Stora-Kaldo process uses an inclined, variable-speed rotating furnace for the reduction of pig iron to steel.

Although the Stora-Kaldo process was developed primarily for the production of steel from Sweden's high-phosphorus iron ore, its ability to produce top quality steel in a broad range of specifications from low-phosphorus iron, more common in this country, has been thoroughly proved.

Using average U. S. pig iron with scrap additions, ingot yields in excess of 91 per cent can be expected in most applications, with blowing rates of more than 3 tons per min. It is estimated that a U. S. or Canadian Stora-Kaldo installation will cost between 50 and 65 per cent less than a new open-hearth shop with similar capacity and auxiliaries.

For a plant with an annual ingot capacity in the range of 1 million tons, using existing open-hearth buildings and auxiliaries, capital requirements for a Stora-Kaldo installation are estimated at less than $8 per annual ingot ton.

Plant designs already have been prepared, heat and material balances have been completed, and economic analyses have been made on the process for a number of proposed applications in this country.

Although the Stora-Kaldo furnace resembles a conventional Bessemer converter, it is rotated at variable speeds up to 30 rpm at an inclined angle of 17 deg from the horizontal with an oxygen pressure of 40 to 50 psi injected into the vessel through a water-cooled lance. Pressure at which oxygen is injected into the furnace produces a quiet reaction and consequent reduction of iron loss in exhaust gases and slag.

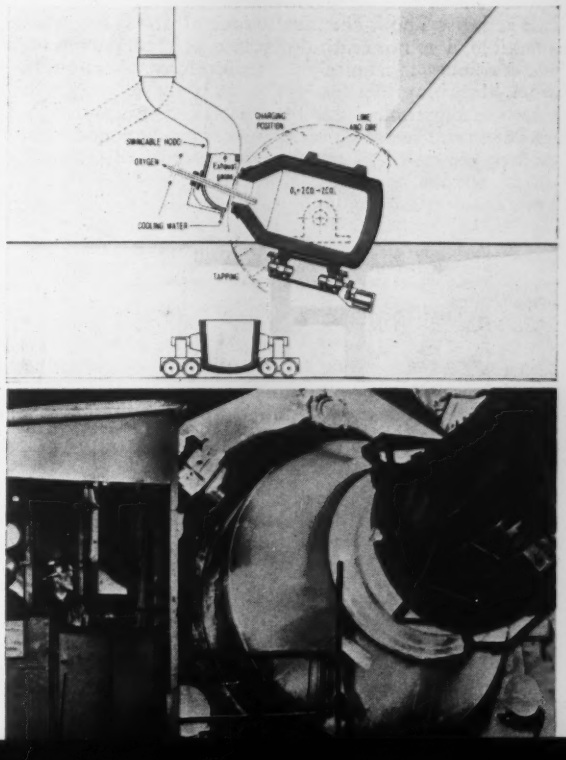
The open-hearth type of reaction at the slag-metal interface inherent with Stora-Kaldo, combined with the rotational characteristic of the furnace, permits selectivity in the elimination of metalloids and produces low-phosphorus, low-nitrogen, and low-sulfur steel at an easy-to-control tapping temperature.

Variation of the rate of vessel rotation and its consequent influence on slag composition and temperature produces a slag with controllable chemistry. It also contributes to high yield.

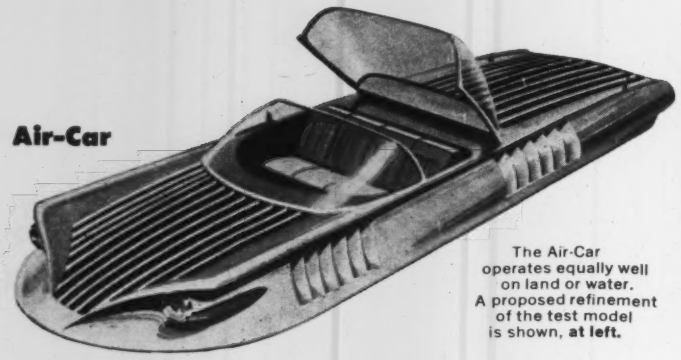
In addition, the ease with which carbon elimination in the refining process can be stopped at a predetermined point minimizes time required for carbon control and eliminates the necessity for recarburization.

Combustion of essentially all CO to CO_2 within the furnace minimizes gas volume and the cost of gas cleaning. At the same time it permits melting of large quantities of iron ore, sinter, or scrap during the refining process, thus producing a high steel tonnage per ton of molten pig iron charged.

The Stora-Kaldo oxygen steelmaking process in operation at the Domnarvet plant of the Swedish firm which developed the process



Air-Car



The Air-Car operates equally well on land or water. A proposed refinement of the test model is shown, at left.

A VEHICLE that rides on a cushion of low-pressure air and can travel in any direction over unobstructed terrain or across bodies of waters has been announced by Curtiss-Wright Corporation (see also "Vehicles Without Wheels," MECHANICAL ENGINEERING, February, 1959, pp. 82-83). It has no conventional wheels, axles, brakes, clutches, transmissions, or frame. Both suspension and propulsion are accomplished by the use of low-pressure, low-velocity air. The suspension of the vehicle is accomplished through maintaining $^1/_{10}$-psi under the vehicle augmented by a deflection membrane.

The Air-Car serves not only as a land and marine vehicle, but has so many potential uses that it is offered for sale in limited quantities for the purpose of developing customer requirements and customer thinking with regard to utilization. After obtaining this information, the sizes, powers, and configurations that will be put into full production will be determined.

Using a conventional piston-type engine ranging in size from 50 to 200 hp, the Air-Car lifts itself 6 to 12 in. off the ground when the engine is accelerated. It will carry from 1 to 4 passengers and travel forward, backward, sideways, or turn in a circle. It weighs approximately 425 lb per passenger or payload equivalent. The experimental model is capable of 30 mph on land or water —cavitation and hull-resistance problems are eliminated. It is limited to 6 per cent grades at present. In production quantities, price will be competitive with autos.

Materials Briefs

▶ Self-Adhesive Foam Tape

A NEW, inexpensive polyurethane-foam tape coated with a unique high-temperature, permanent, pressure-sensitive adhesive is being made by Richards, Parents and Murray, Inc., New York, N. Y. The adhesive will hold permanently in spite of extreme and repeated fluctuations from zero to 300 F, according to the maker.

Both the polyurethane and the adhesive are noncorroding and impervious to moisture. The tape has excellent sound and heat-insulating qualities, superior cushioning against shock and vibration, is an effective seal against dust and dirt, and is chemically inert. The foam, which is flexible, does not crush down into a "compression set" but continues indefinitely to maintain a vibration and shock-absorbing life.

Delicate instruments can be cushioned in installations subject to shock and vibration, doors can be sound dampened or air sealed, windows weatherstripped, office appliances given sound-absorption linings, air-conditioner leaks sealed, and there are any number of other uses.

Bath tape and adhesive in a new inexpensive tape are noncorroding, impervious to moisture, sound, and heat insulating and vibration cushioning

▶ Flexible-Inorganic-Film Electrical Insulation

Many potentially important applications of electrical circuitry at high temperatures are presently hindered by the lack of high quality flexible-wire insulation. Recent discoveries at Bell Telephone Laboratories indicate that fluoride coatings can be formed on copper, aluminum, and other metal wires which will provide exceptionally high insulation value at elevated temperatures while retaining flexibility and freedom from porosity.

The insulating coatings are formed directly on freshly cleaned copper or aluminum by exposing them to oxidizing carriers of fluorine such as hydrogen fluoride or elemental fluorine at temperatures from 300 to 600 C. The thickness of the resulting copper-fluoride and aluminum-fluoride films depends on the temperature at which they are formed, the concentration of fluorine, and the time of exposure. Aluminum forms a fluoride film one micron thick in a few minutes at 550 C. These films remain adherent when bent repeatedly at 90-deg angles.

Electrical insulation values are very high for both copper and aluminum films, being in the order 10^{10} and 10^{11} ohms at room temperature for films in the order of 1 to 2 microns thick, between probe electrodes $^1/_4$-in. in diam. The films retain their excellent insulating properties at high temperatures. For example, aluminum-fluoride films exhibit resistances of about 7×10^8 ohms at temperatures as high as 500 C.

The aluminum-fluoride films show excellent resistance to oxidation even above 600 C. They also show no tendency to hydrate or dissolve on exposure to high humidity. The insulation does not break down even at 450 volts at 500 C.

Water Decomposed by Light

A METHOD for decomposing water into its basic elements by means of a beam of light has been discovered by two New York University scientists. Their work apparently confirms certain theories dealing with photosynthesis in plants and may be useful in future studies concerning solar-energy applications.

The method was developed in the course of basic research into the electrical properties of certain organic crystals. The studies were made by Hartmut Kallman, professor of physics at NYU, and Martin Pope, research scientist at the University's Institute of Mathematical Sciences.

Laboratory equipment used in the project is similar to a solar battery, but the study involves the use of artificial ultraviolet light rather than sunlight. The organic crystal used is anthracene, an inexpensive chemical related to the moth-ball chemical naphthalene.

A flat, circular crystal, 0.0005 in. thick and 0.02 sq in. in area, is mounted in an electrical cell. Each of the two faces of the tiny wafer is bathed in a separate dilute salt solution. This is accomplished by mounting the crystal in a small window of a plastic divider that separates the two salt solutions.

When ultraviolet light is shone on one face of the crystal, the crystal becomes a battery, developing a 0.2-volt potential. This voltage forces a current through a measuring circuit while the light is on. Measurements are made through two silver wires, one in each of the salt solutions.

The power developed by the tiny crystal is of the order of only a millionth of a millionth of a watt.

The fact that current flows through the cell is evidence that water is being decomposed, with hydrogen forming on one face of the crystal and oxygen on the other. This result may be of special significance in the study of photosynthesis, the still imperfectly understood process by which plants utilize solar energy to transform carbon dioxide and water into carbohydrates necessary for growth.

One explanation of photosynthesis places chlorophyll in the role of a photovoltaic generator, which becomes an electric battery under the influence of light. This battery, it is thought, causes water to decompose.

The NYU scientists' study indicates that it is possible for light to decompose water directly if the light is first intercepted by a material of the appropriate molecular structure.

A paper, "Photovoltaic Effect in Organic Crystals," describing this study appears in the February, 1959, *Journal of Chemical Physics*. The project was supported by the Office of Naval Research and the Air Force Cambridge Research Center.

▶ Stainless-Steel or Brighter Chrome Bumpers?

A test automobile bumper made of type 301 stainless-steel clad on both sides of a mild-steel center, made in the form of a sandwich, is in excellent condition after more than two years in service.

One of six bumpers made especially for testing by Allegheny Ludlum Steel Corporation, it exhibits no pitting, peeling, or corrosion and may someday replace the current bumpers made of a mild steel with a coating of chrome flashing.

On the other hand, processes developed by Metal & Thermit Corporation, Detroit, Mich., apply a much thicker layer of chromium than ever before possible and increase corrosion and rust resistance up to 500 per cent, adding years to the life of chrome-plated trim on automobiles.

▶ Die-Casting Die-Core Material

A molybdenum-base alloy for use as a die-casting die-core material is reported by the Die Casting Research Foundation (DCRF), which is affiliated with the American Die Casting Institute, New York, N. Y.

Superior resistance is shown to "heat checking or crazing," which is the most common cause for die failures, particularly when casting the higher temperature metals such as aluminum and magnesium-base alloys and brass.

The alloy resulted from a research program sponsored by DCRF at Battelle Memorial Institute and with the co-operation of Climax Molybdenum Corporation of Michigan, Universal-Cyclops Steel Company, and the testing and production facilities of several of the DCRF member companies.

From hundreds of materials tested, only molybdenum displayed substantial superiority in resisting heat checking.

Molybdenum has only one half the thermal expansion and four times the thermal conductivity of standard steel. Although its hardness is very low at room temperature, it is at least twice that of standard steel at 1500 F, and this can be further increased by improved working and by alloying.

▶ Rubber "Mouse Tails"

Rubber "mouse tails" which eliminate the need for clasps or waxed-string ties for securing components such as resistor capacitors or for tying bundles of wire have been patented by the Boeing Airplane Company which has licensed Rubber Teck Company, Gardena, Calif., to produce them.

To tie down a group of wires, two small holes are drilled in the baseboard of the equipment. The $1\frac{1}{2}$-in-long mouse tail is inserted through one of the holes and then looped over the wires and pulled through the second hole until it is tight. In the process of pulling the rubber through the hole, the cross section of the mouse tail is reduced, so that, when it is released, the expansion holds it firmly.

Wires are simply "tied down" with rubber mouse tails that are inserted through one hole, drawn over the bundle, and pulled through second hole

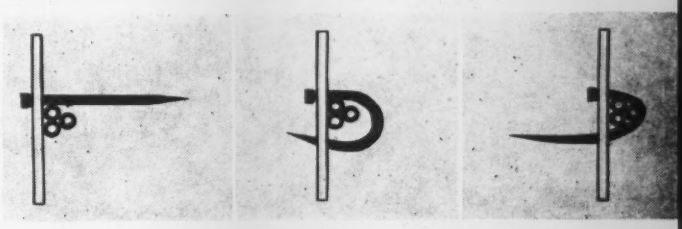
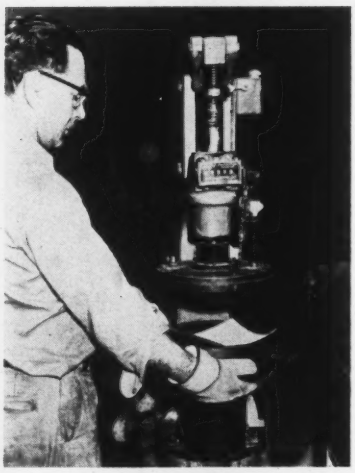


PHOTO BRIEFS

1

1 Pyroceram Radomes. Radomes for the Navy's Tartar missile are being made of Corning Glass Works glass-ceramic, Pyroceram (described in MECHANICAL ENGINEERING, July, 1957, pp. 662–663).

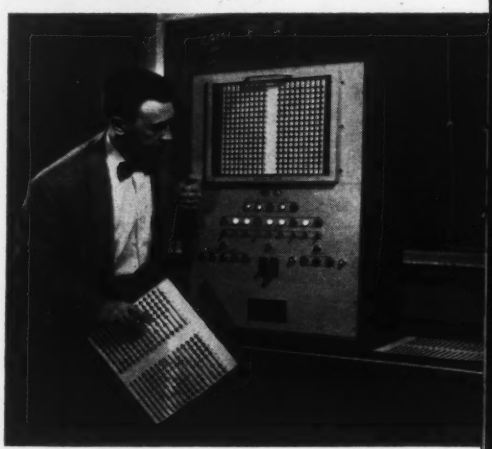


2

2 Cools as It Forms. Water-cooled forming dies eliminate separate cooling of parts in the postforming of certain laminated plastics at Taylor Fibre Company, Norristown, Pa. Method is practical only for runs of over 10,000 parts since die cost is doubled. Special fixtures for separate cooling, and uncurling troubles, are eliminated.

3 Stored-Program Demonstrator. A miniature information-processing machine, which includes 29 relays with 500 contacts and about 1500 wires with 288 "reading fingers," is used at Bell Telephone Laboratories to demonstrate the operation of digital computers and electronic telephone-switching systems. It can be made to perform a new task simply by changing the punched cards. A lighted numerical display accompanies performance of logic or arithmetic functions.

4 Density-Drag Measurement. The density drag of the atmosphere will be measured at previously uncharted altitudes as high as 300 miles with a 9-ft mylar plastic sphere ejected from a rocket as an 18-lb folded package. Balloon inflates when Freon gas is discharged from a small capsule into a hollow plastic strut. An aluminum can will contain a special accelerometer and radio to measure and transmit data on as little as 0.00001 **g** during a 7 to 8-min free-flight period. It was designed by Arthur D. Little, Inc., for the Air Force.



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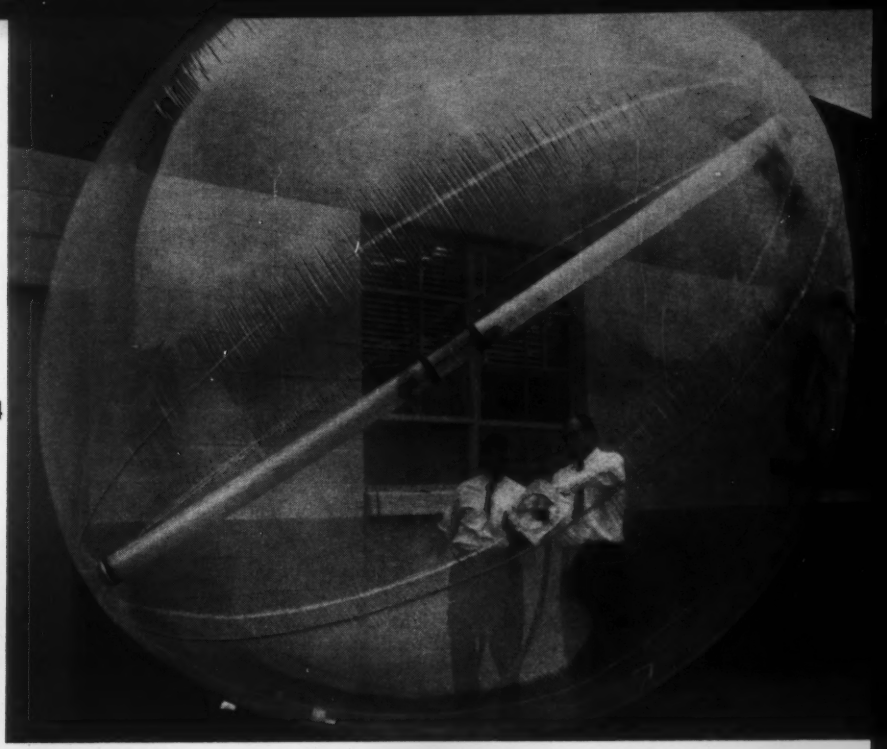
5 Unspliced Hose. Large-diameter hose can be produced in any transportable length with a new secret continuous-production process at Goodyear Tire & Rubber Company.

6 Mobile Sodium-Melting Unit. Two 55-gal heaters liquefy sodium which is then gravity-fed to a foil-insulated transfer tank beneath the platform of a device made by Atomics International. From there it is forced by nitrogen pressure into two filter tanks and transferred to a nuclear test facility, eliminating the need for stationary melting stations.

7 Steel Form for Concrete. An intake trash rack at Trinity Dam, Calif., will be cast in concrete with a steel form made by Blaw-Knox Company. Forms were made to close tolerances to receive structural gates and provide an extremely smooth finish.



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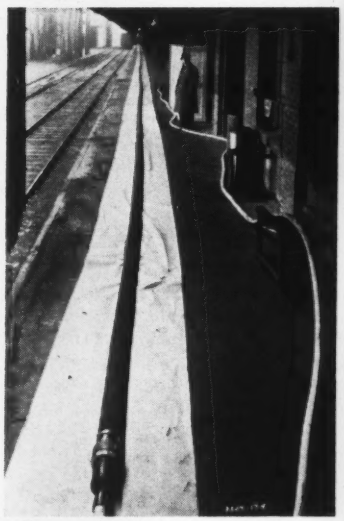

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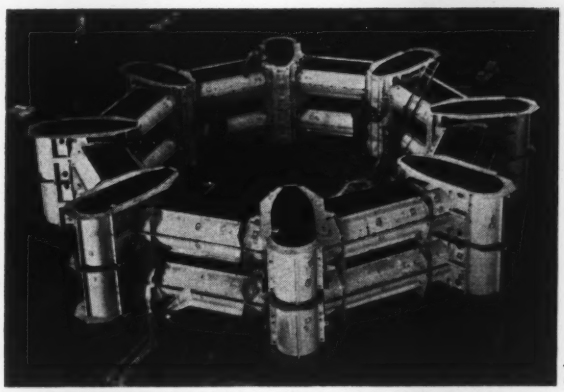

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Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

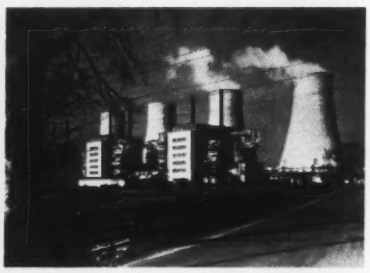
Chapelcross Goes Active

On May 2, 1959, the Chapelcross nuclear power station of the United Kingdom Atomic Energy Authority officially went into service, supplying electric current to the national grid. It is the first nuclear power station to start operating in Scotland, the second in the United Kingdom and (according to Lord Plowden, Chairman of the Authority) only the fourth in the world; the last figure should be qualified, perhaps, by the distinction that it applies to those engaged in contributing to a public supply. The little village of Chapelcross, which the station now dominates, is near the town of Annan, in Dumfriesshire, and was almost unknown outside of its own neighborhood until the Atomic Energy Authority selected it as a site and began to build. The district is on the north shore of the Solway estuary and is mainly agricultural.

With a few modifications and improvements suggested by experience, the Chapelcross station closely resembles the pioneer plant at Calder Hall, in Cumberland, which was connected to the grid by Queen Elizabeth II in October, 1956, and has been delivering current steadily ever since.

Work began on the site a year before Calder Hall started to produce electricity—showing that the Authority had every confidence in the success of the design; but whereas the original Calder Hall plan was for two reactors only, of the gas-cooled graphite-moderated type, using natural uranium, Chapelcross was designed to have four, with a total output of 140 megawatts. The original Calder Hall plant has since been duplicated on that site, but Chapelcross was laid out as a whole, and the plan is therefore rather different, the four units being arranged in line. It differs also from Calder Hall in being provided with a cooling pond, in which the spent fuel elements are deposited until they are safe to transport to the recovery plant at Windscale, about 75 miles away; and in having removable graphite sleeves in the fuel channels, as a safeguard against the "Wigner effect," which had caused trouble at Windscale.

Each of the four reactors at Chapelcross consists of a mass of graphite, 36 ft in diam and 27 ft high, built up of 58,000 bricks closely fitted together and having in it about 1800 vertical channels, of which 1696 contain fuel elements. The other holes are used to accommodate the control rods and instruments. The fuel elements are uranium bars, an inch in diam and 40 in. long, sealed in cans of magnesium alloy which are provided with fins to dissipate the heat; six elements are stacked in each hole, one above another. The heat is removed by pumping carbon dioxide through the reactor at a pressure of 100 psi, and to maintain this pressure the whole reactor is encased in a cylindrical steel pressure vessel, 37 ft in diam, 70 ft high, and with walls 2 in. thick. Four large ducts at the top convey the hot CO_2 to the heat exchangers, in which steam is generated to drive the turbogenerators, and similar ducts return the cooled gas to the bottom of the reactor. The CO_2 flows through at the rate of about a ton per second. The whole reactor is cased in a biological shield of mass reinforced concrete, 7 ft thick, to protect the personnel against radiation, and this is lined with a thermal shield of 6-in. steel plates to keep the concrete cool. Between the shields is a 6-in. air gap through which cold air circulates.



Chapelcross nuclear power station dominates the village of Annan, in Dumfriesshire, Scotland

The heat exchangers are 80 ft high and $17\frac{1}{2}$ ft in diam. Each generates high-pressure and low-pressure steam simultaneously, and has a total heating surface of just under 100,000 sq ft. The steam is delivered to the turbogenerators at 200 psia and a temperature of 590 F from the high-pressure circuit, at the rate of 198,000 lb/hr, and the low-pressure circuit delivers 59,300 lb/hr at 53 psi and 340 F. There are two turbogenerators to each reactor, or eight in all; they run at 3000 rpm and deliver 3-phase current at 11,500 v and 50 cycles. The total capacity for the eight sets is 184,000 kw. The flow rate to the condensers is 257,300 lb/hr from each set. Each condenser has a cooling surface of 32,500 sq ft, in 6894 tubes 1-in. diam, and is cooled by $1\frac{1}{2}$ million gal/hr of water. The cooling-water outlet temperature is 87 F. There are four large cooling towers, each taking the water from two condensers.

While the turbogenerators must on occasion be put on load and taken off again, just as in an ordinary thermal power station, it is not possible to switch reactors in and

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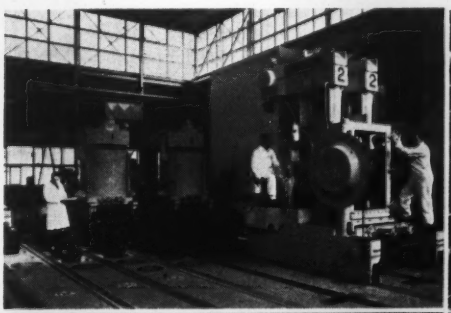
out in the same way; so it is necessary to be able to deal with the steam generated if a particular turbine is not running. This is accomplished by the provision of four dump condensers, in which the unwanted steam can be condensed and the condensate recirculated. Each dump condenser has a cooling surface of 12,000 sq ft, in 4590 1-in. tubes. Its maximum capacity is 514,600 lb/hr with a cooling water rate of 3 million gal/hr.

The cooling pond, which is a special feature at Chapelcross, is a reinforced-concrete structure comprising two rectangular storage tanks with a common division wall. The depth of water is 18 ft and each pond holds about 400,000 gal, this capacity being sufficient to hold a number of elements equal to about three full reactor charges. The irradiated fuel is taken to the pond in steel containers weighing about 50 tons and each containing 24 fuel cartridges. They are transported to the pond on a rail track and lowered into the water by an overhead crane, remaining there for several months until they are cool enough to be taken out and transported by road to Windscale.

The subsoil on the Chapelcross site consists of boulder clay overlying sandstone rock, at depths ranging from 25 ft to 60 ft, and as the concrete biological shields weigh about 9000 tons each, the foundations for them were built directly on the rock. The construction of the graphite moderator presents features of some interest, in view of the precision required. The total weight of the graphite in each reactor is about 1200 tons and this is carried on a "diagrid" of eight I-beams in each direction, surrounded by a ring of I-section. The weight of the diagrid is 36 tons. Each of the 58,000 interlocking graphite blocks is machined to a tolerance of ±0.002 in., and the whole mass is held together by 11 restraining rings, made in 24 parts with knuckle joints.

The heat exchangers, too, present some striking statistics. The total number of studs on the heat-exchange elements in each steam-raising unit is 10,600,000, and the total length of studded tubing in the 16 units is 3200 miles. The shell of each unit weighs about 180 tons and is fabricated from ten sections, including the supporting skirt and the two domed heads. The contractors for these units were Babcock & Wilcox, Ltd., who made the sections in their works at Renfrew, on the river Clyde to the west of Glasgow. The component sections were transported by road to the site and there were circumferentially welded to form the complete shell, weighing about 480 tons empty. Babcock & Wilcox, Ltd., also supplied the handling equipment for the cooling pond. The main contractors for the civil engineering work were the Mitchell Construction Co., Ltd., of Peterborough, England, and the suppliers of the turbogenerators, condensers, and the like, and the 16 gas circulators were C. A. Parsons & Co., Ltd., of Newcastle-upon-Tyne, England. Strachan & Henshaw, Ltd., of Bristol, England, supplied the equipment for inserting and removing the fuel elements. There are two mobile chargers and two dischargers for each reactor. They run on rails on the charging floor and are electrically propelled. Mechanically, chargers and dischargers are practically identical, but the dischargers, having to be heavily shielded against radiation from the elements as they are withdrawn, are considerably heavier than the chargers, and weigh about 60 tons each.

Charge floor of No. 1 reactor shows charge and discharge machines for loading and unloading fuel elements, **top;** graphite base plate, **bottom,** of 69 four-inch-thick steel plates, is installed



Precipitator units in burst-slug detection room in No. 1 reactor, **top;** spent fuel elements are deposited in two cooling ponds, **bottom,** until they may safely be transported to recovery plant at Windscale about 75 miles away

Substance of Briefs of Papers Presented at ASME Meetings

M ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Metals Engineering

A Unified Interpretation of Room-Temperature Strength of Notched Specimens as Influenced by Their Size.....59—Met-9

By B. M. Wundt, General Electric Company, Schenectady, N. Y. 1959 ASME Metals Engineering Conference paper (multilithographed; available to March 1, 1960).

A generalized concept of material behavior in the presence of sharp notches or cracks, which embraces the notch-strengthening of small bars and the notch-weakening of large bars, is proposed. Quantitative explanation of notch-strengthening of small bars follows from the experimental work of G. Sachs and others, and the interpretation of notch-weakening of large bars, the geometric size effect, is obtainable with the help of Griffith-Irwin approach using the strain-energy-release concept. Experimental notch strength versus size curves for notch-tension and notch-bending tests are plotted in an especially useful log-log co-ordinate system. An analytical expression was derived to approximate the foregoing experimentally observed, continuous variation of notch strength. A relationship was derived between the notch strength and relative notch depth for cylindrical tension bars with different outside diameters. The plots indicate a continuity of notch-strength behavior with varying size and varying notch depth.

A Generalization of Cumulative Damage.....59—Met-1

By R. M. Mains, Knolls Atomic Power Laboratory, Schenectady, N.Y. 1959 ASME Metals Engineering Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to March 1, 1960).

In the application of various damage accumulation hypotheses to shock and vibration problems, a pattern of results was observed. A plot of allowable response (for the largest of a sequence of excitations) versus the number of excitations in the sequence produced straight lines on log-log paper for each value of damping.

It seemed likely that a generalization could be found which would relate the allowable response to the largest excitations with a load-distribution factor, a material-and-structure factor, and the material constants from fatigue tests. One form of this generalization is presented, together with some numerical examples of its use and a discussion of its possible significance.

Design of Pressurized Cylinders for High-Temperature Applications.....59—Met-8

By J. F. Traexler, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1959 ASME Metals Engineering Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to March 1, 1960).

Increasing use of higher pressures and temperatures in the power-generation field has led to a renewal of interest in the mechanical design of components subjected to creep. One commonly occurring problem concerns the design of thick-walled pressurized cylinders carrying radial temperature gradients where the stresses and temperatures are such as to cause creep. Clearly, an elastic analysis is meaningless in such cases. This paper presents a stress analysis for such a case assuming the cylinder to be fully plastic and the pressure and thermal loading to be independent of time.

General equations for the stresses in a thick-walled cylinder in a state of plane strain are derived considering "steady-state" creep. A specific form of the creep-rate function is assumed and numerical examples are included to show the effect of geometry and material properties.

Effect of Relaxation on the Behavior of Materials Under Combined Alternating and Static Stress.....59—Met-3

By F. H. Vitovec, University of Wisconsin, Madison, Wis. 1959 ASME Metals Engineering Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to March 1, 1960).

The effect of temperature on the stress range diagram is discussed and the particular characteristics of the curves for unnotched and notched specimens are analyzed.

Excluding metallurgical factors from consideration, it is suggested that relaxation is the principal mechanism which influences the behavior of polycrystalline metals under combined alternating and static stress.

Two parallel nonlinear Maxwell units are used to represent the relaxation mechanism at elevated temperature. An analysis of this model shows that relaxation occurs to an asymptotic finite value of stress which is a function of the initial stress.

The same model is applied for representing the behavior in the stress range diagram with the assumption that a linear relationship exists at low temperature between the fatigue strength and the normal stress acting on the planes of reversed slip.

Creep Rupture Tests for Design of High-Pressure Steam Equipment.....59—Met-14

By E. A. Davis, Mem. ASME, Westinghouse Research Laboratories, Pittsburgh, Pa. 1959 ASME Metals Engineering Conference paper (multilithographed; available to March 1, 1960).

The design of certain steam-turbine components for advanced high-pressure, high-temperature installations such as the Philadelphia Electric Company's Eddystone No. 1 Unit and the Avon No. 8 Unit of the Cleveland Electric Illu-

minating Company demands new investigations into the combined stress behavior of materials to help insure the validity of the design concepts. At supercritical pressures the radial component of stress is of significant magnitude to become a dominant factor in the design of either cylindrical or spherical pressure vessels. With the present-day state of design knowledge, it is perplexing to decide what the allowable design stress should be when using triaxial combined stress formulas where all three stress components are of significant values.

To help fill the void of actual test data on combined stress behavior, the author's company instituted a testing program in which tubular specimens of type 316 stainless steel were subjected to triaxial stresses of various component ratios. Both pure internal pressure and equal biaxial tension tests were run. The test temperature was 1200 F, and pressures up to 24,000 psi were used in making the tests.

This paper suggests a possible means of correlating triaxial test data with data obtained from conventional uniaxial creep tests. It is hoped that thorough analysis of a few complicated tests will shed sufficient light on the triaxial stress-creep problem to permit design standards to be established on the basis of uniaxial tension creep tests.

Effect of Wall Thickness on Stress-Rupture Life of Tubular Specimens .....59—Met-11

By J. T. Tucker, Jr., E. E. Coulter, Assoc. Mem. ASME, and L. F. Kooistra, Mem. ASME, The Babcock & Wilcox Company Research Center, Alliance, Ohio. 1959 ASME Metals Engineering Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to March 1, 1960).

Stress-rupture data obtained from tubular specimens stressed with internal pressure are compared with data from standard tension-bar specimens from the same heats of material. Agreement between the data of the two types of specimens is poor for thick-wall tubes when the hoop stress in the tube wall is calculated on an average stress basis. Better agreement is obtained with thin-wall tubes. These results show that any design formula that neglects the variation of stress through the thickness of a tube wall is unsatisfactory for thicker tubes.

A dimensionless parameter method is presented which provides satisfactory correlation of the data for three materials, four test temperatures, and a wide range of wall thickness. Several areas in which additional research would be of value are discussed.

Report of Project SP-4 to Steam Power Panel of the ASME-ASTM Joint Committee on the Effect of Temperature on the Properties of Metals.....59—Met-12

By J. S. Worth, Mem. ASME, Bethlehem Steel Corporation, Bethlehem, Pa. 1959 ASME Metals Engineering Conference paper (multilithographed; available to March 1, 1960).

Project SP-4 was organized in 1953 because of a request received by the ASME-ASTM Joint Committee on the Effect of Temperature on the Properties of Metals from a Special Committee on ISO/TC11 sponsored by the ASME Boiler and Pressure Vessel Committee. In May, 1953, the International Standards Organization had been working for two or three years toward the preparation of an international boiler code. The Special Committee, which acted also as the secretariat for ISO/TC11, indicated that for export construction American boiler manufacturers would like to have approval of ASTM A212 Grade B plate material, since its higher strength as compared with A201 Grade B would permit some weight reduction.

The task of determining the high-temperature properties of the material was assigned to the Steam Power Panel by the Joint Committee which, in turn, appointed the following Project Committee: R. G. Matters, Allis-Chalmers Company; P. M. Brister, The Babcock & Wilcox Company; C. H. Wheatley and M. A. Scheil, A. O. Smith Company; G. V. Smith, Cornell University; E. H. Davidson, U. S. Steel Corporation; J. G. Althouse, Lukens Steel Company; W. P. Gerhart and J. S. Worth, Project Committee Chairman, Bethlehem Steel Corporation.

Use of the Moiré Effect to Measure Plastic Strains.....59—Met-7

By A. Vinckier, Westinghouse Electric Corporation, Pittsburgh, Pa.; R. Dechaene, Commission pour l'Etude de la Construction Métallique, University of Ghent, Ghent, Belgium. 1959 ASME Metals Engineering Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to March 1, 1960).

A method is described which should prove useful in the study of strain distribution in a metallic member during plastic deformation. Regularly spaced lines are drawn on a test specimen of interest and on a glass plate. After exposure to strain the part is photographed through the grid of lines on the glass.

The strain distortion on the part results in an interference pattern from which the amount of plastic deformation may be calculated.

Notch Rupture Strength of Type 347 Heat-Affected Zone....59—Met-13

By R. J. Christoffel, General Electric Company, Schenectady, N. Y. 1959 ASME Metals Engineering Conference paper (multilithographed; available to March 1, 1960).

Austenitic stainless steels, principally Type 347, have been used in steam-turbine components and piping systems for a number of years. The over-all service performance of this class of materials has been generally satisfactory. However, some cracking difficulties during service have been encountered. In some instances, the cracking encountered in a particular installation was so severe that, where operating conditions permitted, the austenitic piping has been replaced with ferritic piping. Thus the problem can be serious enough to warrant detailed study.

In considering the specific cases of cracking, it was observed that the cracking usually occurred in the heat-affected zone of the base metal and was sporadic in nature. It also appeared that the cracking was produced during service rather than originating from defects produced during fabrication. It also was observed that, though several different welding procedures were used for fabrication, those weld joints which received a post-weld solution-heat-treatment were generally free of service cracking. The cause of the cracking has been attributed to stress-concentration effects from physical notches, high external stresses such as bending stresses and residual welding stresses. While these factors appeared to provide qualitative explanations for the cracking, they still did not offer a completely satisfactory quantitative answer.

Recently, Grant, et al., published some results pertaining to the effect of cold work on the high-temperature properties of Type 347 material. These investigators found that, while cold-working Type 347 produced a significant increase in yield strength, rupture strength, and creep strength, the creep-rupture ductility was drastically reduced. It was speculated that the notch rupture strength also would be reduced as a result of the cold-working.

The heat-affected zone in an austenitic weld joint is cold-worked, or perhaps more precisely, hot-cold-worked over a range of temperatures during welding. Thus it is possible that the notch rupture strength of the heat-affected zone in a Type 347 weld joint may be poor in the as-welded condition. If such were the case, it would be a contributing factor to the cracking which occurred during service in the heat-affected zone of the unstress-relieved weld joints. There-

fore it was decided to conduct an investigation to determine the notch rupture strength of the heat-affected zone of Type 347 weld joints. The results of this investigation are covered in this paper.

Report of Anomalous "Brittle Failures of Heavy Steel Forgings at Elevated Temperatures".59—Met-6

By A. J. Babecki, P. P. Puzak, and W. S. Pellini, Naval Research Laboratory, Washington, D. C. 1959 ASME Metals Engineering Conference paper (multilithographed; available to March 1, 1960).

Steel structures may fracture in either a brittle or a ductile manner. The brittle-fracture mechanism has been investigated extensively and has been shown to occur by the propagation of cleavage cracks which absorb extremely low energy. As a consequence, brittle fractures may often result in catastrophic-type failures which are extensive and usually result in complete loss of the structure.

In ferritic steels this cleavage-fracture phenomenon is temperature-dependent. With an increase in temperature, the fracture is changed from a brittle (cleavage) mode to a ductile (shear) mode.

This paper presents the analysis of failures, after a short period of service, of four large (76-in-OD) heavy-section (15 × 15-in. cross section) ring forgings which served as shrink-fitted retaining rings on billet containers used in the heavy-press aluminum extrusion industry.

Maintenance and Plant Engineering

Practical Aspects of Protective-Coating Specifications..59—MPE-3

By J. R. Allen and G. Mackey, Mem. ASME, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1959 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to March 1, 1960).

Painting costs represent a significant part of over-all construction and maintenance costs, particularly in the chemical and related industries. It was found that a system of specifications and inspection which would reduce costs and meet protective and appearance requirements could be employed satisfactorily to reduce costs.

Before preparation of a coating specification for any given job, it is necessary to obtain certain background information to define the requirements and limitations. These are defined on the basis of the following general considerations:

1 Exposure and service conditions.
2 Substrate material and condition.
3 Shop or field application or combination.
4 Local limitations.
5 Size, shape, complexity, and accessibility.
6 Color limitations or requirements.
7 Economics: Cost versus performance.

Each of these factors is considered individually as a preliminary to preparation of a specification. The specification describes the surface preparation including materials, equipment, techniques, and definition of surface conditions before and after cleaning. The coating system specification lists materials by trade name, selection, and film thickness. Included in the specification also are product description of specified materials, application, inspection, and necessary safety precautions.

Maintenance of Parking Lots and Grounds.....59—MPE-4

By A. K. Carter, Eli Lilly and Company, Indianapolis, Ind. 1959 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to March 1, 1960).

In downtown areas zoned for industry where land is at a premium, property is purchased as it becomes available and is used as parking lots until it is needed for building sites. Parking lots that offer hard surfaces at a minimum cost and yet are not considered permanent have advantages since they can be utilized as building sites quickly and economically. Maintenance of a parking-lot surface is relatively simple.

It is this type of parking lot that is discussed from the construction and maintenance standpoint. The care of lawns and shrubs throughout the growing sea-

Hydraulics

The Inception of Cavitation in Isolated Surface Irregularities.....59—Hyd-12

By J. W. Holl, The Pennsylvania State University, University Park, Pa. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

The inception of cavitation on isolated surface irregularities imbedded in a turbulent boundary layer is investigated experimentally and theoretically. Two families of cylindrical roughness elements having constant cross sections are studied. One family has a circular-arc cross section. The other family has a triangular cross section and was selected to simulate the separating flow which is typical of an actual surface irregularity.

The theoretical minimum-pressure coefficient for the circular-arc irregularities is determined as a function of the relative height of roughness for several values of the boundary-layer shape parameter.

Cavitation tests in the water tunnels of the Ordnance Research Laboratory on roughness elements ranging from 0.002 to 0.5 in. in height indicate that the incipient-cavitation number of an isolated surface irregularity is dependent upon the relative height of roughness, the boundary-layer shape parameter, the velocity, and other variables as yet unknown.

A Shock-Tube Technique to Determine Steady-Flow Losses of Orifices and Other Duct Elements.....59—Hyd-13

By George Rudinger, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

It is frequently desired to determine the losses in a gas flow caused by certain elements in a duct system, such as valves, screens, orifices, or short bends. In a steady flow, the performance of such elements can be measured readily, but a gas-supply system for the high flow rates that are sometimes required may not be available.

It is shown that a simple shock tube is capable of producing appreciable steady-flow rates through a short duct element, such as an orifice, a valve, or a screen. The flow upstream and downstream of the test element and, therefore, also the losses caused by the test element, can be calculated from known initial conditions in the shock tube and pressure measurements at one point upstream of the element.

Experiments to determine the discharge coefficient of a sharp-edged orifice are described as an illustration of the method. The results are in good agreement with available steady-flow data.

Influence of Trailing-Edge Geometry on Hydraulic-Turbine-Blade Vibration Resulting From Vortex Excitation.....59—Hyd-7

By Gunnar Heskestad, Assoc. Mem. ASME, and D. R. Olberts, Assoc. Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

A study was made to determine effects of trailing-edge geometry on the vortex-induced vibrations of a model blade de-

son is outlined on a monthly basis including a general discussion of the control of weeds.

Engineering for Good Preventive Maintenance.....59—MPE-5

By E. R. Schauffele and H. W. Parsons, Atlantic Refining Company, Philadelphia, Pa. 1959 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to March 1, 1960).

Reducing plant maintenance costs has become a necessity for economic survival. Maintenance costs can be reduced in many ways. A few of the methods which are now in use include: Reducing the number of maintenance employees to a safe minimum; training maintenance mechanics and foremen to be more versatile; making use of industrial-engineering techniques; scheduling maintenance.

The authors' company has found that: Equipment lasts longer; maintenance and operating costs are lower; shutdowns are shorter in duration; and preventive maintenance is organized as a result of a co-ordinated maintenance activity.

The firm's Machinery Engineering Unit, as part of its maintenance organization, has achieved these results by:

1 Maintaining close co-operation with the rest of its maintenance organization and with its operating groups.

2 Comprehensive record keeping.

3 Investigation and follow-up of maintenance problems.

4 Control of drawings and standards.

5 Research and development of maintenance items.

The Technique of Efficient Sandblasting.....59—MPE-1

By P. E. Weaver, Assoc. Mem. ASME, The Dow Chemical Company, Baton Rouge, La. 1959 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to March 1, 1960).

For efficient sandblasting, consideration must be given to the following factors:

1 Sand—size of grain, type, freedom from dust.

2 Hose—size and type from air source to blaster and from blaster to nozzle; length of hose.

3 Sandblast nozzle—size and type.

4 Air supply—cubic feet per minute, pressure, freedom from water and oil.

5 Sandblaster—continuous, intermittent.

The author has checked a number of sandblast operations and found that, almost without exception, some or all of the afore-mentioned items had not been considered properly for the job. The efficiency on some jobs was as low as 10 per cent of that possible when proper consideration is given to these items. Sandblasting can, indeed, be very expensive when not done properly.

There is little difference between the cost of good and poor equipment. The cost per square foot for cleaning steel is considerably less when good equipment is used. The price, for example, of a 6-in-long, high-efficiency, tungsten-carbide nozzle is $35. It can be used for 800 hr of blasting, which is only 4.4 cents per hr. Cheap clay nozzles cost only 15 cents each, but after 2 hr of blasting time, they are so badly worn that they waste a considerable amount of sand and, even when new, they will not clean as efficiently as the 6-in. nozzle. This, then, is 7.5 cents per hr for the cheap nozzle. It is obvious, then, that even without considering the time required to change the clay nozzles and the less efficient work they do, clay nozzles cost almost twice as much as do the good nozzles per hour of operation.

The object of this paper is to disseminate information regarding efficient high-grade sandblasting. There is a need for improving sandblasting technique. The importance of using the correct size and type of sand is stressed. Sandblasting costs are greatly reduced by the use of proper equipment and technique. In some instances, the efficiency has been increased by more than 200 per cent. The relative costs of labor, air, sand, and equipment are given.

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signed to simulate the conditions at the trailing edge of a hydraulic-turbine blade. For the type of trailing-edge flow encountered, characterized by a thick boundary layer relative to the blade thickness, the vortex-shedding frequency could not be represented by any modification of the Strouhal formula.

The amplitude of the induced vibrations increased with the strength of a vortex in the von Karman vortex street of the wake; one exception was provided by a grooved edge, which is discussed in some detail. For a particular approach velocity, the vortex strength is primarily a function of the ratio of distance between separation points to boundary-layer thickness, the degree of "shielding" between regions of vortex growth, and frequency of vortex shedding.

Water-Hammer Damage to Oigawa Power Station.....59—Hyd-8

By C. C. Bonin, Ebasco Services Inc., New York, N. Y. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

The Oigawa Power Station is a hydroelectric installation located on the Oi River in Shizuoka Prefecture, about 100 miles southwest of Tokyo, Japan. The power plant was constructed in 1936 and was operated in 1950 by the Japan Power Transmission and Generation Company, Inc. Three Francis turbines operate at a head of 403 ft and develop 32,000 hp maximum each. In addition, there are two smaller turbines, one driving a 600-kva house generator and the other coupled to a stand-by oil pump. Three steel penstocks approximately 9 ft in diam carry water 800 ft from a differential surge tank to the powerhouse.

In June, 1950, errors in operation and malfunctioning of equipment resulted in water-hammer surges which burst one 9-ft-diam penstock of the three-unit 68,200-kw Oigawa Power Station. The accident resulted in the death of three workmen and about one-half million dollars in damage to equipment and powerhouse. This paper reviews the events leading to the penstock failure and the resulting damage.

The Propeller Turbines of the St. Lawrence Power Project.....59—Hyd-11

By G. C. Fintak, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

Although the St. Lawrence River has long been recognized as a great economical source of water power, its development has been delayed until now for many reasons. The major obstacle has been the 125 miles of river which forms the common boundary between the United States and Canada. In this distance lies the International Rapids section of the St. Lawrence River, which necessitated a joint undertaking by both countries if power was to be developed. The St. Lawrence Power Project is the fulfillment of this joint undertaking.

This paper describes the control structure required to harness the river and the design features of the hydraulic turbines which convert the power of this mighty river to useful, dependable electrical energy.

Indentation of Metals by Cavitation .....59—Hyd-15

By W. H. Wheeler, Mechanical Engineering Research Laboratories, Department of Scientific and Industrial Research, East Kilbride, Scotland. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

The first stage in cavitation damage—indentation where cavitation bubbles collapse near the metal surface—was observed and measured by Knapp. The author suggested that the high temperature of indentation points, caused by the absorption of work in their formation, should create conditions favorable to energetic local chemical action between water and metal. The brittle oxide films thus produced would be ruptured by later blows, resulting in erosion.

Photomicrographs taken in monochrome and color show the form and texture of indentations with associated corrosive oxidation. Parallel experiments were made with toluene whose inertness permitted the elimination of chemical factors. The special features of the microscope technique employed to get the photographs are explained.

Separation Prediction for Conical Diffusers.....59—Hyd-14

By J. M. Robertson, Mem. ASME, University of Illinois, Urbana, Ill.; and H. R. Fraser (Colonel), U. S. Military Academy, West Point, N. Y. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

Behavior of numerous fluid devices, including diffusers, is adversely affected by the occurrence of separation. If diffuser flow without separation can be achieved, then high efficiency is possible. However, it appears that the optimum diffuser performance occurs when separation impends near the end of the diffuser. The prediction of diffuser separation has been uncertain even though the study of incompressible-fluid flow in smooth diffusers has received the attention of numerous researchers for the last half century.

A method of incompressible turbulent-boundary-layer analysis based on the D parameter introduced by D. Ross is applied to conical-diffuser flow.

The separation conditions are shown to depend on the initial momentum-thickness Reynolds number and a distance parameter involving the initial momentum thickness, the initial radius, and the diffuser length.

Comparison with experimental information on diffuser separation indicates that the predictions are reliable, but conservative.

Unsteady Transfer of Momentum and Heat Between Concentric Cylinders.....59—Hyd-17

By Chia-Shun Yih, University of Michigan, Ann Arbor, Mich. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

Problems of the molecular transfer of momentum and heat in a fluid between two concentric cylinders are often encountered in the field of lubrication.

It is shown herein that these problems can be solved by a generalized Fourier analysis, and that, in particular, varying boundary conditions and nonhomogeneous terms in the diffusion equation which are time-dependent can be treated by the Duhamel method from the theory of the conduction of heat in solids.

Heat generated by viscous shear, as well as that externally applied, is included in the analysis.

Chamber Dimension Effects on Induced Flow and Frictional Resistance of Enclosed Rotating Disks... .....59—Hyd-9

By J. W. Daily, Mem. ASME, and R. E. Nece, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

Fundamental fluid mechanics associated with the rotation of a smooth plane disk enclosed within a right-cylindrical chamber has been studied both experimentally and theoretically. In order to acquire further and systematic information pertinent to this problem, which has received much attention in the past, torque data were obtained over a range of disk Reynolds numbers from 10^3 to 10^7 for axial clearance-disk radius ratios s/a from 0.0127 to 0.217 for a constant small radial tip clearance, and velocity and pressure data were obtained for laminar and turbulent flows.

The existence of four basic flow regimes in the axial gap between the disk and casing wall was verified, and these regimes, the existence and extent of which are governed by the Reynolds-number axial spacing combinations, have been delineated.

A new approximate theoretical analysis has accounted for axial-clearance effects for the case of separate boundary layers on the disk and end wall; this theory has been checked against test results. Velocity and pressure data have shown that the concept of a fluid "core" rotation in the case of separate boundary layers must be modified because of secondary flows and skewed boundary layers.

On the Three-Dimensional Turbulent Boundary Layer Generated by Secondary Flow.....59—Hyd-6

By J. P. Johnston, Ingersoll-Rand Company, Phillipsburg, N. J. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

A problem that has interested designers of turbomachinery and fluid dynamicists concerns the nature of the boundary layer on a flat wall under the influence of a turning main flow. Many practical problems involve flows of this type; for instance, flow on the end wall bounding a compressor cascade. Often the Reynolds number of the flow is high enough to insure that the boundary layer is fully turbulent. Thus the many well-known methods developed for three-dimensional laminar boundary layers offer little or no help to the designer.

In this paper a study of the secondary-flow type of three-dimensional turbulent boundary layer is presented. Two objectives are achieved: (*a*) A mathematical model of the relationship between the crossflow and main-flow components of the velocity vectors of the layer is established. (*b*) By utilization of the model some of the relationships required to carry out a boundary-layer problem solution by the use of the momentum-integral equations are developed.

Three-Dimensional Flow Considerations in the Design of Turbines.... .....59—Hyd-1

By W. L. Stewart, W. J. Whitney, and H. J. Schum, Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio. 1959 ASME Hydraulic Conference paper (multilithographed; available to Feb. 1, 1960).

Results of a series of investigations made to determine the significance of three-dimensional flow considerations in the design of turbines are presented.

Fundamental concepts and equations used in turbine analysis and design procedures are first presented to indicate how the more important factors affecting the velocity distribution through the turbine blading can be considered.

The results of the investigation of three mixed-flow turbines are then described to point out some of the operational problems encountered as a result of three-dimensional effects predictable by flow analysis in the radial-axial plane.

Finally, the results of an investigation of an axial-flow transonic turbine (utilizing rotor-hub entrance Mach number of approximately unity) are presented to indicate the degree of success obtained with this very critical turbine by use of a design procedure which included the flow-analysis concepts in both the radial-

axial and blade-to-blade planes as integral parts in the determination of the surface velocity distribution.

An Experimental Investigation of Radial Thrust in Centrifugal Pumps .....59—Hyd-2

By A. Agostinelli, Assoc. Mem. ASME, D. Nobles, Mem. ASME, and C. R. Mockridge, Mem. ASME, Worthington Corporation, Harrison, N. J. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

Among the problems with which a centrifugal pump designer must cope is the unbalanced radial load on the impeller caused by the nonuniformity of the static pressures and velocities within the volute, particularly at off-design conditions. Unless shaft and bearing designs are modified to compensate for higher loads, the resultant shaft deflection due to this radial load can sometimes be of sufficient magnitude to cause rubbing at close running clearances with the consequence of premature wear on the parts in contact. Furthermore, the load is cyclic because of rotation and can lead to shaft failure due to fatigue. Hence it is important that the radial forces acting on the impeller be given consideration in the mechanical design of a centrifugal pump.

An experimental investigation has been conducted to determine the magnitudes and directions of the unbalanced radial forces on centrifugal pump impellers. The work covers single volutes for a wide specific speed range, double volutes, concentric casings, and modifications of the concentric casing. The results are presented in graphical form and are discussed.

A method, making use of strain gages, was devised for determining the magnitudes and directions of the resultant radial forces and is described.

Crossover Systems Between the Stages of Centrifugal Compressors .....59—Hyd-3

By G. O. Ellis, Carrier Corporation, Syracuse, N. Y. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

The location and orientation of vanes in an annulus are established on the basis of two principles which result from a discussion of simple elbows. These principles are incorporated into a procedure for designing the diffuser vanes in the crossover passage between stages of a centrifugal compressor. To test the proposed design, a low-speed model was built and tested and the results compared with a second model which represented a more conventional design.

Firmoviscous and Anelastic Properties of Fluids and Their Effects on the Propagation of Compression Waves.....59—Hyd-19

By F. D. Ezekiel, Mem. ASME, and H. M. Paynter, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Hydraulic Conference paper (multilithographed; available to Feb. 1, 1960).

In any real fluid, the propagation of acoustic waves will always be accomplished by a dispersion or scattering action, resulting in part from the astatic nature of the compressive modulus.

While the resulting significant dissipation of available energy can be related readily to simple dynamic properties of the fluid substance, lack of appreciation of these properties has retarded the accumulation of adequate experimental data.

All experimental data known to the authors reinforce the belief that such a compressive model as that proposed in the paper is of the minimum complexity which will still explain the scattering action readily apparent in observed behavior of fluids. Thus we strongly urge that a concerted effort be made to reduce such observations to the point where the anelastic properties of the more common fluids can be established firmly.

Discharge Coefficients and Steady-State Flow Forces for Hydraulic Poppet Valves.....59—Hyd-18

By J. A. Stone, Assoc. Mem. ASME, International Business Machines Corporation, New York, N. Y. 1959 ASME Hydraulic Conference paper (multilithographed; available to Feb. 1, 1960).

A poppet valve is a seating-type valve in which the moving element or poppet, usually spherical or conical in shape, moves in a direction perpendicular to its seat. Because of the several advantages that are associated with poppet valves, such as ease of manufacture, minimum leakage, and insensitivity to clogging by dirt particles, poppets have been used for years as pressure regulators and relief valves.

Experiments were run on a poppet valve operating in hydraulic oil. The experimental values of the flow forces and discharge coefficients were about 25 per cent below the predicted theoretical values. Although there was some scatter in the values of discharge coefficients, there was good correlation for the flow forces.

Flow forces are strongly influenced by the downstream configuration. The smaller the diameter of the downstream chamber, the higher the forces. A poppet configuration was designed and tested which virtually eliminated the flow forces.

Design and Test of Mixed-Flow and Centrifugal Impellers.....59—Hyd-20

By J. J. Kramer and W. M. Osborn, National Aeronautics and Space Administration, Cleveland, Ohio; and J. T. Hamrick, Mem. ASME, Thompson Products, Inc., Rocky Mount, Va. 1959 ASME Hydraulic Conference paper (multilithographed; available to Feb. 1, 1960).

Interest in the field of mixed-flow and centrifugal impellers resulted in the undertaking of a program to develop reliable design procedures that would obviate the need for lengthy development work. This program was based on the philosophy that proper control of the fluid velocity on the wetted surfaces of the machine was the key to good over-all performance. The procedure followed, in general, was to develop a method that enabled the designer to control the wetted-surface velocities and then to investigate the reliability of the design method by over-all performance tests of specific impellers designed by the method.

All the design procedures were based on isentropic-flow models so that real fluid effects were neglected in the design. To compensate for this, experiments were conducted in order to discover that modifications to the isentropic design shape were required to compensate for viscous effects.

Blade-design procedures also were used to produce diffuser vanes, and tests were conducted to determine the performance of these diffusers in combination with one of the mixed-flow impellers.

The Fluids Engineering Laboratory at the University of Michigan.....59—Hyd-16

By G. V. Edmonson, Mem. ASME, University of Michigan, Ann Arbor, Mich. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

Although the purpose of this paper is specifically that of describing the Fluids Engineering Laboratory at the University of Michigan, it is clear that an understanding of the faculty philosophy underlying the planning of this unit is a necessary part of the document.

This is an age of technological expansion, the rate-of-change of which exceeds any progress the world has hitherto known. The seeking of new knowledge and the application of that knowledge are the work of an ever-increasing number of competent scientists and engineers not only skilled in a technology but equally successful in the art of human understanding and relationships.

Institutions of higher education are an integral part of this technology age and,

because of this fact, find themselves confronted with the task of foreseeing the educational and research needs of the future. This is an immense task, one which is occupying many of the best minds of this generation. The technological and social progress of the coming generation depends upon the continuing flow of students emanating from our institutions of learning. They must be adequately prepared for the responsibilities which they alone can assume.

Ejector-Nozzle Flow and Thrust. . . . . 59—Hyd-5

By H. E. Weber, Assoc. Mem. ASME, General Electric Company, Danville, Calif. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

An analysis for predicting the secondary and primary flows and the thrust coefficient of ejector nozzles is presented. Particular attention is given to the diverging shroud ejector in which the throat of the secondary stream is formed at a small distance downstream of the primary nozzle exit; that is, near the plane of the minimum shroud area.

The basic assumption in the analysis is that the shroud is sufficiently short so that the mixing of the two streams is incomplete, and that both streams have isentropic cores. The momentum thickness of the mixing region is obtained from the momentum-integral equation for the turbulent mixing region assuming that momentum and temperature diffuse at the same rate.

The momentum thickness at the nozzle exit is related to the initial momentum thickness created by the wall separating the two streams. The exit-momentum thicknesses of the mixing region and the wall are used to obtain the actual thrust coefficient. Experimental data on primary-secondary flow properties and thrust coefficients of a divergent-shroud ejector nozzle show good correlation with the theory.

Pressure Losses in Smooth Pipe Bends. . . . . 59—Hyd-4

By H. Itō, Tohoku University, Sendai, Japan. 1959 ASME Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

The results of extensive experimental studies to determine the pressure losses for turbulent flow in smooth pipe bends of circular cross section are presented in this paper. To make the data usable in practical design problems, the results are discussed in relation to those found by previous investigators, and empirical formulas for the bend-loss coefficient are given. The general correlation of the test data appears to be as good as the present test information will permit.

Volute Pressure Distribution, Radial Force on the Impeller, and Volute Mixing Losses of a Radial Flow Centrifugal Pump. . . . . 59—Hyd-10

By H. W. Iversen, Mem. ASME, R. E. Rolling, and J. J. Carlson, Assoc. Mem. ASME, University of California, Berkeley, Calif. 1959 Hydraulic Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Feb. 1, 1960).

A standard volute-type, radial-flow, centrifugal pump was instrumented to obtain the pressure distribution in the volute and also the bearing reactions from the pump hydraulic force transmitted to the shaft.

The resultant force from the integrated pressure distribution was found to give a reasonable design approximation of the radial force. An analysis of hydraulic conditions within the volute gave pressure distributions and radial-force magnitudes that were comparable to those measured with certain qualitative interpretations about internal recirculations.

In addition, the pressure-distribution analysis furnished an interpretation of the effect of the volute on the pump head-capacity performance with corrections to the impeller head. The predicted head-capacity relationship had the form of the measured pump performance.

Aviation/Space

Comparison of Several Propulsion Systems for a Mars Mission. . . . . 59—Av-46

By R. S. Kraemer and V. R. Larson, Rocketdyne, A Division of North American Aircraft, Inc., Canoga Park, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Several propulsion systems proposed and studied for space flight are compared. Attention is focused on propulsion design features, but strong influence of the over-all mission requirements is apparent throughout.

An important mission consideration is whether the vehicle should be manned or unmanned. A propulsion system for a manned flight requires many extra features such as landing and return capability, failure detection and shutdown devices, and the like. However, a period of extensive exploration of space and the nearby planets should be made with unmanned instrument carriers before the attempt is made to carry man to these regions. Accordingly, the typical mission considered in this paper is the establishment of an unmanned instrumented payload in an orbit about Mars. From such an orbit, extensive data on the environmental conditions of heat, cold, radiation, particle bombardment, and such, can be transmitted back to Earth to pave the way for the intelligent design of later vehicles which would carry a manned crew to Mars.

In this report the trip to Mars is assumed to be initiated by a booster system employing the $1^1/_2$-million-lb-thrust chamber engine presently under development. Such a booster can place upper stages of approximately 25,000 lb into a 300 n mi terrestrial orbit. This initial gross weight and orbit height is used as the point of departure for all the space propulsion systems considered in this paper.

Within the limited scope of a propulsion comparison, consideration is restricted to only those factors believed to have a major relative effect between the systems under evaluation. Thus the designs as illustrated are simple propulsion-system schematics and are in no way intended to represent complete vehicle designs.

Propulsive energy requirements are first established, followed by a discussion of six typical propulsion systems to fulfill the mission. Finally, the systems are compared on the basis of their over-all performance in terms of payload.

Typical trajectories for placing an unmanned payload into an orbit about Mars were calculated. For the high-energy, but thrust-limited, ion propulsion system, a continuous acceleration of 10^{-4} g was assumed, resulting in a total trip time of approximately 356 days. For the chemical and nuclear propulsion systems, an initial thrust-to-weight ratio of 0.5 or greater was employed to minimize propulsion energy requirements. The resulting trip time by way of Hohman ellipse was approximately 259 days.

The six typical space propulsion systems were analyzed and weight estimates made from preliminary design sketches. Over-all vehicle performance was determined in terms of relative payload capability for each of the typical propulsion systems. Of those systems capable of early development, the two-stage fluorine/hydrogen propulsion system produced the greatest payload, followed, in order, by the two-stage

nitrogen tetroxide/hydrazine storable liquid system, the two-stage chlorine-trifluoride/lithium hydride hybrid system, and the three-stage ammonium perchlorate/polyurethane solid propellant system. With further development, increased payload capability can be achieved with a single-stage liquid hydrogen nuclear propulsion system. Still higher payloads up to 32 per cent of the gross weight are promised by the single-stage ion propulsion system using cesium as the working fluid.

The treatment throughout this study was necessarily simplified and limited to a few typical propulsion-system types. However, the results are believed indicative of the performance which can be realized from the various classes of space propulsion systems.

An approximate condition for the occurrence of drainage of this type is given for the case of sudden acceptance of full load from a zero-flow condition. This result and the condition for the perpetuation of oscillations of constant amplitude are compared with experimental data obtained by the author from a hydraulic model.

Some Radiator Design Criteria for Space Vehicles.....59—Av-29

By J. P. Callinan, Loyola University of Los Angeles, Los Angeles, Calif.; and W. P. Berggren, University of Bridgeport, Bridgeport, Conn. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Rejection of surplus heat during space flight requires the design of radiators that are radiators in the strictest sense of the word.

Radiator configurations for space vehicles may be classified as single-surface or double-surface. The former type may be built into the skin of the vehicle, the latter would be independent assemblies carried in the plane of the vehicle axis. In both cases the vehicle should be oriented (at least during periods of heat rejection) to keep the radiator surface in the same plane as the solar vector, unless shielded from solar radiation by the vehicle. Double-surface radiators might be nose-mounted for minimum energy interception by the vehicle.

From an analytical point of view three general types of radiators have been considered in this study. These are:

1 Radiators whose surfaces have a constant temperature in the direction normal to the direction of the flow of fluid and whose geometric view factor F is 1.0.

2 Radiators which have intermittent fluid passages and therefore cyclic variation in the surface temperature in the direction normal to that of fluid flow, and whose geometric view factor is 1.0.

3 Radiators which have intermittent fluid passages and whose view factor is a function of position on the surface.

The three types are analyzed for surface temperature distribution and for view factors in the case of fin-and-tube geometry. Methods and examples of maximizing heat rejection per unit weight are given.

A Comparison of Long-Duration Secondary-Power Schemes for Space Vehicles.....59—Av-39

By A. P. Kelley, AiResearch Manufacturing Company of Arizona, Phoenix, Ariz. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Seven basic schemes for converting solar or nuclear radiation to electricity are reviewed. The status and limitations of each of these schemes are noted.

The closed-heat cycle employing a hermetically sealed turbo-alternator is selected as the scheme offering the earliest availability for space power applications requiring above a few kilowatts of electrical power.

Considerations governing the selection of a cycle and the working fluid are discussed. Developmental problems, particularly those associated with space considerations and temperature conditions, are treated.

Engineering problems common to closed turbomachinery cycles—leakage and bearings, pump design, and solar collector design—are briefly discussed.

It is concluded that substantial additional developments will be required before reliable long-duration power supplies are available.

Power for Satellites.....59—Av-3

By J. H. Huth, Mem. ASME, The Rand Corporation, Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The trend in electrical power requirements for space vehicles continues to be upward.

For power requirements up to a few kilowatts, solar-energy converters may be the most effective. In this area the two most promising lines of approach are: (*a*) Concentration of sunlight to produce a high temperature source; and (*b*) conversion directly to electricity through a quantum process (the use of solar batteries). The two possibilities are discussed.

Batteries as prime power sources are discussed particularly since their ultimate performance is calculable from the principles of electrochemistry.

Nuclear power supplies as an ultimate source of large amounts of power for extended periods are also treated. The factors which govern the choice between the use of isotopes or a reactor are noted.

Logistic Support to Man's Ecology in Space.....59—Av-56

By J. E. Mangelsdorf, Lockheed Aircraft Corporation, Sunnyvale, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Man's ecology in space—the total environment adequate to the maintenance of sound physical and mental health and the accomplishment of assigned missions—is an essential factor in the success of a manned-satellite mission.

Logistic support—a program which will furnish timely replenishment of certain elements of the ecology—is therefore necessary.

Space stations will operate in an essentially closed-system, closed-loop fashion, and most of the internal loops must be carefully balanced if the crew is to perform its assigned tasks in addition to its survival efforts.

This paper discusses the ecological elements with which the system must provide the satellite crew. Provision for potable water and nutriment and a means of ingestion; gases for breathing; disposal of body wastes; protection from thermal, noise, radiation, psychological, and G-stresses are treated in some detail.

It is shown that the solution of the problem of man's ecology in space requires talent from a number of technical areas. The author briefly examines the Lockheed Ecological Model, first as a means of illustrating man's metabolic exchange, and second, as a tool for solving some of the problems of designing for long-endurance, manned satellites.

The Penetration of Planetary Atmospheres.....59—Av-27

By Carl Gazely, Jr., Assoc. Mem. ASME, The Rand Corporation, Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan., 1960).

The problem of atmospheric penetration arises for any vehicle which approaches a planetary atmosphere and for which physical recovery or survival is desired at the planetary surface. This includes a number of possibilities from simple sounding rockets to manned vehicles returning from interplanetary trips.

The approach to a planet from space is presumed to involve the classical technique of first getting the vehicle into the planet's solar orbit and then "fall-

ing" into the planet. The approach velocity is, then, essentially the escape velocity of the planet—corresponding to a parabolic orbit. (In the vicinity of the earth, the escape velocity is about 37,000 fps; a highly eccentric elliptical orbit, such as a circumlunar orbit, involves a velocity almost as high—about 35,000 fps.) It is expected that rather precise control of velocity and direction would be required to obtain a hit or a near-miss. A direct hit would involve an entry path similar to the ballistic rocket but with a higher initial velocity. A more gradual descent can be accomplished by either a tangential shallow entry or by first maneuvering into a satellite orbit and then descending.

Although the heating and deceleration accompanying atmospheric entry bring about severe design problems, the presence of a planetary atmosphere is advantageous in that it acts as a cushion to reduce a space vehicle's velocity to a safe landing speed. Otherwise, one would be forced to the costly expedient of rocket braking. Landing on the moon, which has effectively no atmosphere, requires an appreciable portion of the vehicle's weight to be allocated to a braking rocket. Landing on a planet with an atmosphere requires a clever approach shot, a surface-cooling scheme, and/or a clever aerodynamic design.

The problems of penetrating a planetary atmosphere are reviewed, and techniques for penetration are discussed. These techniques are resolved into two general classes: (*a*) Gradual entry into the atmosphere with relatively low deceleration loads and heating rates low enough so that the heat may be rejected by thermal radiation from the surface; and (*b*) direct entry with higher deceleration loads and higher heating rates with the heat being absorbed by the body surface.

Application of Variable-Area-Nozzle Refrigeration Turbine for Supersonic Aircraft....59—Av-41

By L. Sawamura, Convair, A Division of General Dynamics Corporation, San Diego, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

A variable-area-nozzle refrigeration turbine system has been developed for the F-106 interceptor.

The high air-flow requirements for the F-106 and distribution of electronic components throughout the aircraft make an air cycle system much more attractive than a vapor cycle system, which would require recirculation of cooling air within the aircraft.

The simple bleed-air-cycle system consists of a ram-air heat exchanger, a turbocompressor unit, and an ejector assembly.

Bleed air is extracted from the high-pressure section of the main engine compressor, cooled in the ram-air heat exchanger, and adiabatically expanded in the refrigeration turbine. The energy produced by the turbine is absorbed by the ram-air compressor which provides the primary air for an ejector arrangement which aspirates cooling air through the heat exchanger. During ground operation when there is no ram-pressure rise, the ejector is the only means of getting cooling air through the heat exchanger.

Weight of the assembly is approximately 85 lb. The heat exchanger is a three-pass cross-counterflow design with a core of 14 × 21 × 7 using dimpled tubes of stainless steel. The turbine wheel diameter is 5.3 in. and the compressor wheel diameter is 7.0 in.

The nozzle mechanism moves the annular ring which establishes the turbine nozzle area. The effective area obtainable from this unit range from a minimum value of 0.39 sq in. to a maximum value of 1.66 sq in.

Although the idea of a VAN (variable area nozzle) is not new, the F-106 is the first production airplane to use a turbine of this type in a refrigeration unit. Since this unit was a development item, its initial cost is high, but its production cost will run approximately twice that for fixed nozzle turbines. This makes the VAN system costs comparable to two fixed nozzle turbines operating in parallel with a suitable valving arrangement to give a stepwise variation in air flow with altitude. However, two units operating in parallel would take up more space, with the additional problem of developing suitable controls to phase in and out one of the turbines without setting up objectionable pressure surges in the system.

The advantages and disadvantages for a refrigeration system of this design and methods for extending the performance capability of this system to higher aircraft speeds and altitudes are discussed in this paper.

Analysis of the Aerodynamic Heating for a Re-Entrant Space Vehicle ..... 59—Av-5

By M. J. Brunner, Mem. ASME, General Electric Company, Philadelphia, Pa. 1959 ASME Aviation Conference paper (in type; to be published in Trans. ASME—*J. Heat Transfer;* available to Jan. 1, 1960).

One of the prime design considerations for a blunt-nosed re-entrant space vehicle is the aerodynamic heating imposed during re-entry. The heating characteristics such as the magnitude of the heat flux, total heating, and heating time will depend on the re-entry trajectory, the geometry of the vehicle, and the nature of the heating (turbulent or laminar). The heating characteristics for a space vehicle will have a considerable influence on the configuration and vehicle design. It is therefore necessary to establish an accurate evaluation of the aerodynamic heating so that proper considerations can be given to the heat protection system requirements for the space vehicle.

An analysis of the aerodynamic heating is presented through the trajectory and over the surface of a re-entrant hypersonic space vehicle. Bodies exhibiting zero and high lift over drag ratios are considered. The turbulent and laminar convective heat inputs are specified as functions of the trajectory and space-vehicle parameters. The maximum heating rates and time-integrated heat fluxes are given as functions of the local pressure distribution, body geometry, and wall temperature. Examples are presented to illustrate the application of this analysis.

Air Conditioning and Pressurization of the Convair 880 Turbojet Transport..... 59—Av-40

By B. F. North, Convair, A Division of General Dynamics Corporation, San Diego, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The emergence of high-speed, high-altitude aircraft capable of transporting relatively large groups of people long distances has pointed up the requirement for finely engineered environmental control systems. The integrity of these systems must be of a high order, yet operational requirements must impose a minimum penalty to the aircraft. This is highly desirable today and will be essential with the advent of supersonic transports.

The actual attainment of comfort conditions through widely varying environmental conditions is at present analytically achieved only through empirical methods. The final determination of the proficiency of any system design will, in the end, result from statistical evidence of customer approval.

Design criteria utilized in development of air-conditioning and pressurization systems for a near-sonic turbojet transport with a nominal capacity of 100 passengers are presented. The basis for system selection is discussed and a description of the selected system is given. Results of component and system tests, as well as the total planned test

program, are reviewed. Over-all system predicted performance is presented.

The Martin-Denver Rocket-Missile Testing Facilities.....59—Av-7

By R. S. Williams, The Martin Company, Denver, Colo. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The ballistic missile testing philosophy, as established and as operating in the Titan program, sets down two general principles. The first, test the systems early; the second, rely on ground tests.

The new Martin Missile Plant in the hills of Denver provides, within one complex integrated system, development and testing facilities for the Titan ICBM. Included in these facilities are provisions for the complete program of testing required to support the progressive development of the weapon system, from the component stage through the captive-test and flight-test program.

The facilities can be seen to represent the kinds of instruments necessary for the implementation of the testing philosophy for the ICBM program, and, indeed, for any large-scale weapon-system development. The progressive qualification of thousands of components and subsystems, as they are combined into the final weapon system, lead to the requirements for testing facilities such as the component development laboratories in the General Purpose Laboratory and Propulsion Laboratory, subsystem testing equipment such as the Vertical Test Fixture, and system testing facilities such as the Denver Captive Test stands, backed up by the data acquisition and data-reduction systems needed to quickly put useful development data into the hands of the designers.

The Handling and Transportation of Nuclear Fuels.....59—Av-58

By D. L. Hillis, The Ralph M. Parsons Company, Los Angeles, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The problems associated with handling nuclear fuels are divided into logistic problems, normal handling procedures and hazards, abnormal hazards, and the ultimate disposal of the fuel.

The supplying of "cold" fuels is not normally hazardous and presents no difficult problems. Handling of "hot," or used, nuclear fuels must be done remotely and requires elaborate, shielded structures for disassembly and maintenance operations. Normal hazards and the threat of possible disasters dictate large separation distances between the test or launch stand and operating personnel and the general public. "Used" fuel must be returned to the Atomic Energy Commission for processing and reissue.

Although chemical propulsion systems for missiles and satellites presently appear to be able to deliver as much power as can be effectively harnassed, nuclear systems show promise for certain future applications. They would be especially useful, for instance, where large amounts of power are required for relatively long periods of time. Nuclear systems are frequently mentioned in connection with interplanetary travel.

We are many years away from the time when a nuclear-powered rocket will be sent to Mars or Jupiter. It is not, however, too early to start considering some of the problems that will be encountered when nuclear propulsion becomes a reality. One of these problems is the logistics and handling of nuclear fuels.

Technique of Temperature Prediction in Thermal-Lag Machines.....59—Av-44

By P. M. Mueller, Jack & Heintz, Inc., Cleveland, Ohio. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

A straightforward approach to the solution of the problem of predicting transient temperatures in an electrical machine operating under thermal lag conditions is presented.

The machine is approximated by considering the four main masses and heat generating components of the machine. An energy balance for these is expressed in the form of a set of simultaneous differential equations. These equations are solved and the solution programmed for an electronic computer to facilitate calculations. Experimental results are presented and compared with the calculated solution.

Instruments and Regulators

A Thermocouple System for Measuring Turbine-Inlet Temperatures.....59—IRD-1

By M. E. Ihnat and W. C. Hagel, General Electric Company, West Lynn, Mass. 1956 ASME Instruments and Regulators Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

During the testing and operation of turboprop and turbojet aircraft engines, gas-temperature measurements are required to determine performance and to protect vulnerable machine parts, such as turbine buckets, from premature failure. For both functions, it has been customary to position several Chromel/Alumel thermocouples either in the engine exhaust gas stream or occasionally in the turbine inlet—provided that about 1600 F is not exceeded. Depending on operating conditions, the lower exhaust and the higher turbine-inlet temperatures may or may not be directly related; hence, large safety factors are usually applied for adequate protection. Since real knowledge of turbine-inlet temperature permits greater efficiency and reduces safety hazards, it should be measured with a direct sensing system rather than by inference. The advantages are many; e.g., an aircraft operating at a Mach number of one would realize a thrust gain of more than 30 per cent by changing turbine-inlet temperature, if known accurately, from 1550 to 2000 F (843 to 1093 C).

A fast-response, unique thermoelement combination of platinum, 15 per cent iridium, and palladium, whose emf output is about three fourths that of Chromel/Alumel at 2000 F (1093 C), has been found reliable from 1800 to 2300 F (982 to 1260 C) for more than 400 hours in a combustion atmosphere. A new, stable nickel, 4.3 per cent silicon matching-lead-wire alloy was prepared for use up to an ambient temperature of 1400 F (760 C). Additional tests provided the best choice of insulation, thermocouple dimensions, sheath material, connectors, and harness design for aircraft jet engines. While it has heretofore been impractical or very difficult to determine turbine-inlet temperatures above 1600 F (871 C), this system is capable of measuring directly the most critical of all operational variables and accordingly allows safe potential increases in engine performance.

Estimating the Roots of the Characteristic Determinant for Multicoupled Systems.....59—IRD-2

By S. Lees, Massachusetts Institute of Technology, Cambridge, Mass.; H. D. Felsenthal, Naval Air Missiles Center, Point Magu, Calif.; and E. M. Goldberg, Naval Air Development Center, Johnsville, Pa. 1959 ASME Instruments and Regulators Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

Physical systems with several inter-

acting inputs and outputs are frequently encountered in engineering practice. Aircraft, for example, are associated with at least six degrees of freedom, requiring six outputs and, generally, even more inputs. The design of such systems, particularly controlled-system design, often requires a study of the possible dynamic characteristics of the system as the parameters are varied.

A procedure is developed, based on Cauchy's residue theorem, for bounding the undamped natural frequency, damping ratio, and real part of the roots of the characteristic determinant associated with a multicoupled system with several inputs and outputs. The method can lead to a locus of the roots as one or more parameters are varied. The underlying theory is developed and a numerical illustrative example is included.

Dynamic Response and Control of Multipass Heat Exchangers.....59—IRD-6

By Mazami Masubuchi, Yokohama National University, Yokohama, Japan. 1959 ASME Instruments and Regulators Conference paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

The transfer functions obtained by dynamic analysis of one shell pass and 2, 3, 4,. . . ., 2n, 2n + 1 tube-pass heat exchangers as a distributed parameter system are presented in dimensionless forms. The heat-exchange processes are found to be governed by the third-order characteristic equations with complex coefficients, and can be solved numerically using a graphical method. The numerical examples are presented to show the clear difference of frequency response for such cases when no solid capacity exists. The analog computer and the experimental results are found to be in good agreement with the theoretical results.

Control of Shell and Tube Heat Exchangers.....59—IRD-14

By A. R. Catheron and S. H. Goodhue, The Foxboro Company, Foxboro, Mass.; and P. D. Hansen, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Instruments and Regulators Conference paper (multilithographed; available to Jan. 1, 1960).

A study was made of the problem of selection of control systems for a standard unit of process equipment. The heat exchanger was chosen because it is widely used and because it represents a classically difficult control problem. The two stock shell-and-tube exchangers of moderate size that were tested proved to be neither as difficult nor as slow as had been anticipated.

The investigation resolved itself into two parts; first, a study of the heat exchangers alone to determine their dynamic characteristics as precisely as possible; and second, a study of the practical operation of the exchangers under several control arrangements, with the relative performances examined and discussed. Both are steam-to-water exchangers. The temperature of the output water was the controlled variable in each case. Three approaches to the control problem were tried. The paper includes a detailed description of the equipment, a statement of the circumstances under which each control system would be applicable, and a discussion of performance obtained with each system.

On a New Approach to Filtering and Prediction Problems.....59—IRD-11

By R. E. Kalman, Research Institute for Advanced Study, Baltimore, Md. 1959 ASME Instruments and Regulators Conference paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

The classical Wiener problem (filtering and prediction) is re-examined in the discrete case using the author's new ("state transition") method of analysis of dynamic systems. The general solution is developed in the terms of conditional expectations. This gives results of the greatest possible generality when only first and second-order statistical averages are used. Basic concepts of the theory of random processes are reviewed.

Shannon's Theory and Feedback Systems.....59—IRD-12

By S. S. L. Chang, New York University College of Engineering, New York, N. Y. 1959 ASME Instruments and Regulators Conference paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

Feedback can be used as a means of realizing Shannon's predicted errorless capacity of a noisy communication channel. On the other hand, Shannon's information theory can be used as a guide for rating feedback control systems as well as selecting system components. A brief summary of the former aspect, and the results from some preliminary investigations of the latter aspect are presented. Included topics are: Calculations of required information capacities of control systems from input characteristics and fidelity requirements; required information capacities of system components; and calculation of information capacities of system components from saturation limits, threshold levels, and transfer functions.

Synthesis of the Strongly Interacting Control Loops.....59—IRD-10

By M. D. Mesarovič, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Instruments and Regulators Conference paper (multilithographed; available to Jan. 1, 1960).

In the consideration of a complex control system consisting of numerous interrelated control loops, much attention has been paid to the possibility of achieving a total independence of the control loops.

In theory, the problem is reduced to defining the adequate set of equations which give sufficient conditions for the independence of the control loops. In practice, however, achieving independence is possible only when the subsystems interchange relatively small power.

In this paper a method of consideration of complex control systems is explained. The interrelations are taken as a consistent property of the system, and in some stage of the analysis even a "total dependence" (coherence) will be assumed.

Analysis of Electrohydraulic Pressure Control Servovalve Performance and Loads.....59—IRD-9

By W. L. Kinney, Cook Technological Center, Morton Grove, Ill. 1959 ASME Instruments and Regulators Conference paper (multilithographed; available to Jan. 1, 1960).

Use of idealized pressure rather than flow control of hydraulic power eliminates the effects of oil and system compliances in the output response. Practical limitations to ideal pressure control in presently available electrohydraulic servovalves are discussed and a transfer function for such valves is developed.

Comparisons are made between system dynamic open-loop response with various loads using representative flow-control and pressure-control servovalves. Root-locus techniques are used to investigate expected closed-loop responses and results are verified experimentally. Optimum loads for pressure-control servovalves are discussed.

The Design and Analysis of a Servovalve With Flow Feedback.....59—IRD-3

By E. Bahniuk, Borg-Warner Corporation, Bedford, Ohio; and S.-Y. Lee, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Instruments and Regulators Conference paper (in type; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

Almost all conventional servovalves operate on the principle of controlling the position of a four-way or three-way

valve made with very high precision with the hope that the flow rate will follow accurately the input signal to the valve. In this paper, an entirely new approach to the servovalve design is presented. A flow signal instead of valve position is used in the feedback loop. This design eliminates the necessity of a high precision valve, gives a greater length of the life expectancy of the valve, and minimizes the effect of load variation as well as supply pressure variation. Dynamic analysis and test results of the flowmeter and the complete valve are given.

Bang-Bang Versus Linear Control of a Second-Order, Rate-Type Servomotor.....59—IRD-13

By P. F. Meyfarth, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Instruments and Regulators Conference paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

A simple nonlinear scheme for controlling a second-order, rate-type servomotor is described. This scheme is referred to as "bang-bang" control since the input to the servomotor is made to "bang" from its maximum value in one direction to its maximum value in the other direction depending only on the sign of an error signal.

This bang-bang system oscillates in a continuous high-frequency, low-amplitude limit cycle. The nature of this limit cycle is studied by the describing-function approximation and by an exact method. The step and frequency-response characteristics of the bang-bang system are discussed and compared with the characteristics of a simple linear system. It is shown that many aspects of the behavior of the bang-bang system can be predicted from rather simple considerations.

Human Body as an Inconstant Heat Source and Its Relation to Clothes Insulation, Part 1, Descriptive Models of the Heat Source..59—IRD-7

By A. S. Iberall, Mem. ASME, Rand Development Corporation, Cleveland, Ohio. 1959 ASME Instruments and Regulators Conference paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

A precise investigation of the thermal resistance of clothes requires an accurate description of the static and dynamic thermal characteristics of the human-heat source. Experimental measurements on the human have revealed a frequency spectrum of sustained thermal-power oscillations that mask theoretical long-time equilibrium adjustments. This points to the number of degrees of freedom that must be involved in the thermoregulation of the human, and the specific nonlinear characteristics of the system. Therefore, at best, a resistance model for clothes is possible only as an ohmic relation among time-averaged equilibrium values, and for a specific mode of operation of the system. The validity of this hypothesis, however, has not been proved.

Human Body As an Inconstant Heat Source and Its Relation to Clothes Insulation, Part 2, Experimental Investigation Into Dynamics of the Source.....59—IRD-8

By A. S. Iberall, Mem. ASME, Rand Development Corporation, Cleveland, Ohio. 1959 ASME Instruments and Regulators Conference paper (multilithographed; to be published in Trans. ASME—*J. Basic Engng.*; available to Jan. 1, 1960).

Quantitative measurement on the human in the so-called evaporative, vasomotor, and metabolic-control regimes has revealed frequency spectrum of sustained power oscillations with approximate periods of 2, 7, 35 min, and $3^1/_2$ hr independent of the regime. Step-function adjustments take place with a time constant of about 7 min. It is believed that the $3^1/_2$-hr cycle represents the shortest equilibrium cycle.

The hypothesis that it might be possible to measure the resistance of clothing as an ohmic relation among time-averaged equilibrium values, and for a specific mode of operation of the system, has now been put in rational context in the time domain.

Two equilibrium modes of the human system were explored. The active mode of operation of the system, to which the resistance concept of clothes is most applicable, is as a feedback system in which the extremities are used as error indicators of deviations from a comfort-level set point. In response to deviations, the human feeds back a signal to generate an activity level in which only internal work—immediately degraded into heat—is done to maintain the comfort level. This is referred to as the comfort mode of operation of the system. Another "survival" mode of operation of the system is also described.

Frequency Response of Multipass Shell-and-Tube Heat Exchangers..59—IRD-4

By Lewis Iscol and R. J. Altpeter, University of Wisconsin, Madison, Wis. 1959 ASME Instruments and Regulators Conference paper (multilithographed; available to Jan. 1, 1960).

A multipass shell-and-tube exchanger may be described by a set of partial differential equations similar, in many respects, to those describing a counterflow or one-side lumped exchanger. This set of equations may be thought of as constituting a mathematical model of the exchanger. Models of varying degrees of complexity may be constructed for the same exchanger. In this paper models are first constructed which neglect the heat capacity of tube walls. Refinements are then made which allow the walls to be introduced as either lumped or distributed thermal capacity.

The models presented herein are quite formidable of aspect, involving the definition of many sets of intermediate parameters. It should be borne in mind that the question which must be answered regarding the feasibility of use of a given model is not, "How complicated is the model?" but, "How much does it cost to extract the desired information from the model?" The desired information is here the frequency-response characteristics of the exchanger. This information may be particularly easily extracted if an explicit expression is obtainable for the transfer function. Such an expression is obtainable for the models considered. In fact, it is the object of this paper to show how such explicit transfer functions may be obtained.

Transfer functions are derived for exchangers with one shell pass and $2n$ tube passes. It is shown how the method of derivation may be generalized to apply to exchangers with an arbitrary number of shell-and-tube passes. Distributed thermal capacity in pipe walls may be introducted as such, lumped, or neglected entirely.

The Storage and Retrieval of Nonnumerical Data in Large and Complex Documentation Systems.....59—IRD-5

By Allan Kent and J. W. Perry, School of Library Science, Western Reserve University, Cleveland, Ohio. 1959 ASME Instruments and Regulators Conference paper (multilithographed; available to Jan. 1, 1960).

Introduction of automatic routines for the precise selection of pertinent information from large document collections covering broad areas of subject matter requires a careful analysis of the input and output phases of the documentation system used. A simplified model has been hypothesized to provide a universe of information with which to study various information-retrieval systems, and to provide a basis for characterizing and later identifying information which involves no uncertainty. Some of the problems involved when uncertainty is introduced are discussed in qualitative terms.

Railroads

Load and Life Relationship of Roller Bearings as Applied to Railroad Journals.....59—RR-1

By A. D. Edelman, Mem. ASME, General Motors Corporation, Harrison, N. J. 1959 ASME-AIEE Joint Railroad Conference paper (multilithographed; available to Feb. 1, 1960).

Antifriction bearing capacities are based on fatigue life of the bearing elements. As a result of controlled laboratory tests over many years, the bearing manufacturers have amassed much information on the fatigue life of their bearings. Each bearing manufacturer has a capacity rating for the various bearings which he supplies. These ratings have been calculated from formulas derived from specific life testing of the particular design of bearing and the specific materials used therein.

Bearing capacity must always be thought of in terms of load-carrying capacity at a specific speed tied in with a specific life expectancy. The bearing manufacturer's catalog usually specifies load ratings of bearings at some speed in revolutions per minute and some expected life in hours.

This paper is confined to determining the life expectancy in miles of roller bearings applied to railroad journals. This determination resolves itself into a problem with two distinct parts.

The first, is to make sure when comparing bearing ratings that they are based on the same speed and life expectancy. If not, the ratings must be reconciled so that they are on the same basis. The second part of the problem is to determine the effective load on the bearing in the particular application.

The first part of the problem stems from the fact that bearing manufacturers do not rate their bearings in the same manner. Some speak of life on the basis of 1,000,000 revolutions of the shaft, while others relate life to hours of operating time at a certain speed. This time basis varies within the industry from 2000 to 10,000 hr.

Technical Research on European Railroads.....59—RR-2

By P. V. Garin, Mem. ASME, Southern Pacific Company, San Francisco, Calif. 1959 ASME-AIEE Joint Railroad Conference paper (multilithographed; available to Feb. 1, 1960).

The European railroads afford a fresh viewpoint on many of the problems which confront their American counterparts.

The level of technical competence on the European railroads, their well-coordinated research program, and their enthusiasm for new ideas and developments are notable. The progress in locomotive design is particularly impressive. This is largely due to the fact that the design groups are separated from the maintenance groups concerned with everyday problems and that there is a greater emphasis on technical research and development among the railroads themselves.

The European railway system has been modernized more in the past 10 years than it had been during the previous 50 years. They have adopted up-to-date techniques and have improved equipment design to lower costs, facilitate maintenance, and increase productivity.

European railways differ in many respects from the railways of the United States. The most obvious difference is that in Europe the principal railway systems are government-owned or controlled. Most of them, with a few notable exceptions, operate at a financial loss. This fact naturally changes the philosophy and, in many instances, the general outlook of the transporation industry in Europe. Added to this, of course, are the entirely different labor situations, the strong national feelings and interests in each country, and the various languages and customs encountered. Population densities, shorter distances between major cities, lighter equipment, lower tonnages handled, available sources of power, lower permissible rail loading and clearances—all have influenced modern European railroad thinking and practices.

However, in spite of these natural barriers and complicating factors, there is an active movement toward standardization and co-ordination of ideas in the field of technical research and equipment development not only in the railroad industry itself but also in the efforts of the Office for Research and Experiments (ORE) of the International Union of Railways (UIC). This organization is centered at Utrecht, Netherlands, and many technical research problems are being actively handled by competent groups of experts from the various railways. These problems relate to materials, equipment design, and construction as well as tracks, bridges, signals, transmission lines, and other fixed structures. In the latter categories investigation of rail welding methods and concrete ties are included.

Detailed observations are given on the French, Italian, German, Swiss, Dutch, Belgian, and British railways. The activities of the ORE are described. Passenger-train development in Europe (including Trans-Europ-Express rail cars) and freight-car development are also treated.

Gas Turbine Power

The Basic Heat Transfer and Flow Friction Characteristics of Six Compact High-Performance Heat-Transfer Surfaces.....59—GTP-2

By W. M. Kays, Mem. ASME, Stanford University, Stanford, Calif. 1959 ASME Gas Turbine Power Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Jan. 1, 1960).

In this paper the basic characteristics of six new compact high-performance surfaces are presented. Four are of the strip-fin type, including three stacked in a unique multiple sandwich arrangement. One of the surfaces has perforated fins formed by punching circular holes through the fins, and one has wavy fins. The basic characteristics are presented in terms of N_{St}-$N_{Pr}^{-2/3}$ and f versus Reynolds number. A sufficient geometrical description is provided so that the data are readily usable in heat-exchanger design analysis. The triple-sandwich surface introduces some new complications in the analysis of the effectiveness of the fins, and this problem is considered in an Appendix.

Effect of Ambient and Fuel Pressure on Spray Drop Size...59—GTP-3

By S. M. De Corso, Westinghouse Research Laboratories, Pittsburgh, Pa. 1959 ASME Gas Turbine Power Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Jan. 1, 1960).

After a brief review of existing knowledge concerning the effect of ambient pressure on spray drop size, results are presented for a swirl nozzle at fuel Δp's of 25 and 100 psi for ambient gas pressures of 0.5, 14.5, and 114.5 psia. The liquid sprayed is diesel fuel, the nozzle capacity being 45 gal/hr at 100 psi Δp, and the nominal spray angle, 80 deg. The photographic method by which drop size was determined is described. Curves are presented which show the spatial variation in fuel flow rate, spray-stream velocity, and drop size. The notable effects are large drop size and velocity variations across the spray stream, and for the total nozzle output, an increase in the drop size as the ambient pressure goes from 14.5 to 114.5 psia. Some ramifications of the results are discussed.

ASME TRANSACTIONS

The June, 1959, issues of the Transactions of the ASME—*Journal of Applied Mechanics* and *Journal of Basic Engineering* (available at $1.50 per copy to ASME Members; $3 to nonmembers—contain the following:

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171 Unsteady Laminar Boundary Layers Over an Arbitrary Cylinder, Kwang-Tzu Yang. (58—A-49)

179 On Journal Bearings of Finite Length With Variable Viscosity, L. N. Tao. (58—A-75)

184 Analysis of Complex Kinematic Chains With Influence Coefficients, J. Modrey. (58—A-74)

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199 On Critical Speeds of a Shaft Supported by a Ball Bearing, Toshio Yamamoto. (59—APM-12)

205 Root-Locus Analysis of Structural Coupling in Control Systems, R. H. Cannon, Jr. (58—A-65)

210 Normal Vibrations of Uniform Plate Carrying Any Number of Finite Masses, W. F. Stokey and C. F. Zorowski. (58—A-28)

217 Transients in Simple Undamped Oscillators Under Inertial Disturbances, Antongiulio Dornig. (58—A-58)

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227 Direct Determination of Stresses in Plane Elasticity Problems, P. S. Theocaris. (58—A-43)

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241 Influence Coefficients for Edge-Loaded Short, Thin, Conical Frustums, J. H. Baltrukonis

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Includes Letters from Readers on Miscellaneous Subjects

COMMENTS ON PAPERS

A Century of Fear and Hope at the Crossroads

To the Editor:

In the March issue of Mechanical Engineering, pp. 44–45, I have read an article by Edgar N. Schieldrop entitled "A Century of Fear and Hope at the Crossroads." I think that the suggestion for action which the author has made is most constructive and that it should be followed up by the Society and by the ECPD.

For many years we in the engineering profession have been criticized for failing to meet our responsibilities toward the broader aspects of social development. It seems to me that if we were to adopt a course such as has been proposed, we might go a long way toward showing that the criticism is unwarranted and, more important, by stirring the imagination of people generally, make a further substantial contribution toward a better future for the world.

L. L. Youell.[1]

[1] Vice-president, Stone & Webster, Canada, Ltd., Toronto, Ont., Canada. Mem. ASME.

Petroleum Techniques for Steel

Comment by D. C. Brown[2]

The acceptance today of the H-Iron process[3] and economic feasibility of the new direct reduction processes by an industry long plagued by failures in this area, while not entirely enthusiastic, is one of quiet optimism. There is, I believe, little doubt in the minds of steelmakers relative to the ultimate success of direct reduction. There is, however, some difference of opinion as to which process best fits which need and when.

Indications are that by 1980, ingot capacity will increase 40 to 50 million ingot tons over the present 140 million tons. While today 45 to 50 per cent of the iron in ingot comes from scrap, it is doubtful that scrap will continue to supply this percentage because:

1 High-quality scrap is difficult to come by and high in price.
2 Operating economies in open hearths result from high hot metal practice.
3 Much steel is going into end uses not conducive to producing scrap.
4 Tramp elements in scrap are increasing.

If scrap is not going to maintain its present position, the iron values must come from iron ore, either in the form of hot metal or as a "substitute" scrap. It can be estimated that about 75 per cent of this 40 million tons of incremental capacity should come from virgin iron values.

This then is where direct reduction comes into its own, but not to a degree sufficient to fill the indicated deficit. While it is doubtful if many more blast furnaces will be built, it is certain that steelmakers will make the most of the potential in present-day blast-furnace plants. I believe it safe to predict that existing blast furnace capacity could be increased 50 per cent by changed practices and improved auxiliaries. This 50 per cent increase would amount to 35 to 40 million ingot tons, the full deficit anticipated. This path, however, is expensive and going all the way may not be indicated. Furthermore, it means expansion of steelmaking at its present location. Markets will, however, dictate the erection of grass-roots plants and it is doubtful if only conventional plants will be built. Thus direct reduction followed by electric furnaces or by hot blast cupola-basic oxygen furnaces may be installed. Direct reduction has three primary uses:

1 To produce hot metal via hot blast cupola.
2 To produce replacement scrap.
3 To beneficiate, reduce, and agglomerate lean ores.

The first two uses would be located at steelmaking facilities. In the third use, certain iron ores may be more advantageously prepared for steelmaking by direct reduction of the crude ore and subsequent magnetic beneficiation at the mine.

Which of these uses will come first is open to question. Certainly, making replacement scrap will come early, with direct reduction to produce metallics for new installations being largely dictated by market considerations. Direct reduction on lean ores is unpredictable.

Certain direct reduction processes, such as the H-Iron process, can make good and direct use of the fine-size concentrates from lean ores. Undoubtedly, the trend to concentrates will continue. Only through beneficiation of lean ores with control of agglomerate structure is it possible to produce blast-furnace burdens which allow maximum capacity to be reached. Thus the amount of high-grade concentrates available for consideration as raw material for direct reduction processes will undoubtedly increase with time.

With regard to reductant, installations for a scrap substitute would probably be made at existing steelmaking facilities where fuel oil and natural gas are available. In the case of grass-roots installations, the possibility exists of buying hydrogen or CO/H_2 mixtures directly from refinery or petrochemical installations. Installations at the mines working on crude lean ores would undoubtedly, for the immediate future, use either solid carbonaceous fuel or fuel oil or resid stock, either directly or to generate reducing gases.

The H-Iron process enjoys a considerable amount of prestige in the steel-

[2] Assistant director of research, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

[3] F. D. Hoffert, E. A. Kelly, and A. M. Squires, "Petroleum Techniques for Steel," Mechanical Engineering, January, 1959, vol. 81, pp. 27–30.

making community. It has undergone a greater degree of development than any other gaseous reduction process. In no other process is the use of refinery engineering techniques more extant. The development of this process indicates a great deal of "imagineering" on the part of Hydrocarbon Research and Bethlehem Steel and represents a fruitful and exciting extrapolation of petroleum techniques into the roots of a serious problem in a basic nonallied industry. The unconventional approach taken has undoubtedly raised some reservations in the minds of steelmakers not familiar with handling inflammables at high pressures.

I believe it safe to say, however, that no one direct reduction process will fill all direct reduction needs. The H-Iron process is quite versatile and will definitely receive its fair share of attention.

Convair "600" Jet Transport

Comment by Norman R. Parmet[4]

IN READING this paper[5] I was struck by the fact that nowhere therein is the Convair 880 airplane mentioned, although the 600 airplane is essentially a development of the 880 in a manner similar to that in which the Super Constellation is a development of the Constellation airplane. Aside from leading edge slats, aerodynamic bumps, the use of the fan engine, increased fuel capacity, and increased fuselage length, the airplane described is essentially the 880 airplane. It seems to me that Convair should be proud of their basic 880 airplane and should have related the development of the 600 with respect to the 880. It is also interesting to note that Convair has established as standard, on the Model 600, certain installations which were forced into the 880 airplane by the airline ordering equipment. Examples of this are the electrically driven vapor-cycle refrigeration system and the 6000-rpm generator speed.

One final comment. We heartily applaud Convair's statement that all systems and units be engineered and located so that they are readily accessible and can be maintained and serviced with the least possible interference with flight utilization. With respect to this comment we would suggest that Convair review their design to see whether or not they are living up to their press notices on the airplane. It is one thing to say you are designing an airplane for good maintenance characteristics—it is another thing to do it.

[4] Director—Aircraft Development, Trans-World Airlines, Inc., Kansas City, Mo.

[5] J. T. Ready, Jr., "The Convair '600' Jet Transport," MECHANICAL ENGINEERING, vol. 81, February, 1959, pp. 59–62.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

Missiles

Fundamentals of Advanced Missiles

By Richard B. Dow. John Wiley & Sons, Inc., New York, N. Y., 1958. Cloth, 6 × 9¼ in., figs., tables, index, xvi and 567 pp., $11.75.

Reviewed by Thomas L. Keller[1]

IN THIS book the author has set out to gather into one convenient package, and to explain, the basic concepts behind all of the engineering aspects of guided missile systems. Astonishingly (and I use this word to indicate my primary reaction as I first thumbed through the pages) he has, for the most part, succeeded. He has managed to make readily available to the person who is generally familiar with engineering or science but is a relative layman in certain specific fields a talking and, perhaps, a preliminary thinking knowledge of the many diverse disciplines needed for an understanding of missile-system behavior.

The book begins with a chapter on flight kinematics and proceeds in an orderly fashion through fluid mechanics, internal and external aerodynamics, rigid body mechanics and control-system dynamics, applications of probability and statistics including communication theory, guidance and guidance electronics including microwaves, radar and infrared, and concludes with a chapter on whole systems, more or less from the operations-analysis standpoint. Each of these categories contains an astounding array of information ranging from theory to description of equipment.

The author starts each section with a brief but lucid introduction and moves rapidly to a discussion of the subject at hand on what might be termed by an expert in the field an "intermediate" level. He has a great deal of material to discuss in a relatively small space, however, and in no sense does he spoon-feed it to the reader; a fair amount of concentration and independent thought is required for complete absorption of all that is offered. In this sense the book seems to be primarily useful as a sort of text handbook, perhaps, for engineers working in one area of aircraft or missiles who feel the need for something more than the usual mere acquaintanceship with the other areas.

I can think of only a few minor criticisms. One is the relative lack of bibliographic material, particularly books, for a work of this tremendous scope. True, there are a fair number of references listed in footnotes, but I had the continual feeling of being left stranded. Another is the excessive use of footnotes (there are

[1] Group leader, guidance and detection, Research Department, Grumman Aircraft Engineering Corporation.

some 850 throughout the book) which I found to be quite distracting since I am usually not able to pass one by without reading it. A third is an occasional, not-too-serious, lapse in grammar or syntax, which is certainly forgivable here.

All in all, the book is a real tour de force and will be a genuine contribution to the library of any engineer in the missile business, and perhaps of some not in it.

Air Pollution Control

Air Pollution Control

By W. L. Faith. John Wiley & Sons, Inc., New York, N. Y., 1959. Cloth, 6 × 9¼ in., illus. tables, appendix, index, vii and 259 pp., $8.50.

Reviewed by Frederick S. Mallette[2]

SINCE 1954, the author has been associated with the Air Pollution Foundation and, in 1957, became its managing director. He represents the American Institute of Chemical Engineers on the ASME Committee on Air Pollution Controls.

He has made excellent choices for discussion among the complexities of the air-pollution problem, and has described them clearly and concisely. The chapter headings are: The Air Pollution Problem; Meteorology; Smoke; Dust, Fumes, and Mists; Odors; Automobile Exhausts; The Air Pollution Survey; and Legal Aspects. There is also an appendix of conversion factors for common measurements and an index.

Naturally, in a book of this size, comprehensive treatment is not possible nor can every aspect of the problem be considered. The author points this out in the preface and also states that he is aiming at the nontechnical laymen, more of whom every day make acquaintance with the air-pollution problem through civic activities.

Nevertheless, the field is considered in detail and extensive reference lists are provided so that even the technical person who wishes to have available a broad view of the whole problem may find material of value.

In line with modern thinking, the chapter on automobile exhaust presents a rather complete picture of this relatively new but now accepted factor in the air-pollution problem. Of particular interest are the various tables which offer an over-all view of the extensive research effort now being devoted to this phase.

The rôle of automobile exhaust gases is explained in detail and its importance in the Los Angeles area can readily be understood in view of the almost 3 million motor vehicles registered in the Basin (Los Angeles and Orange Counties) in 1957. The enormous quantity of hydrocarbon vapors from this source can be appreciated when using the author's assumed figure of 5 to 7 per cent for unburned gasoline in automobile exhaust gases.

The author foresees several trends in air-pollution legislation; greater restriction, enlargement of control areas, and more research by government. On the other hand, he describes certain "countertrends" such as self-policing by industry, the assumption of responsible parts by industrial or trade association groups, and community approaches to the solution of the problem.

[2] Executive Secretary, ASME Committee on Air Pollution Controls.

BOOKS RECEIVED IN LIBRARY

Sampled-Data Control Systems
By Eliahu I. Jury. 1958, John Wiley & Sons, Inc., New York, N. Y. 453 p., 6 × 9¼ in., bound. $16. Discusses the basic theory of sampled-data control systems in particular and circuits, networks, computers, and system engineering in general. A general approach is provided to mixed digital-analog linear systems along with a thorough discussion of the z-transform method which can be applied to a wide variety of fields. Problems arising in feedback control systems are solved and discussed by means of application of digital computers. General applications of the z-transform method and the operational solution of linear difference equations are enumerated and clarified.

Short-Time High-Temperature Testing
Published 1958, by the American Society for Metals, Cleveland, Ohio. 137 p., 6 × 9¼ in., bound. $6. Papers dealing with the following topics: Strength of metals undergoing rapid heating; the fluid analogy to aerodynamic heating; short time creep of structural sheet metals; effect of holding time and strain rate on the tensile properties of structural metals; a programming universal elevated-temperature testing machine. These papers constitute the proceedings of the Symposium on Short-Time Elevated-Temperature Testing of Metals held in Los Angeles in 1957.

Steam Turbine Performance and Economics
By Robert L. Bartlett. 1958, McGraw-Hill Publishing Company, Inc., New York, N. Y. 317 p., 6 × 9¼ in., bound. $12.50. A guide to power-plant performance which gives information on the preparation of turbine-heat balances, including the data required for these calculations; the results of extensive comparative performance calculations indicating differences for steam conditions, cycle changes, turbine type, etc.; methods whereby comparative performance data may be estimated to suit a variety of applications. Features of the book include extensive information on performance of single reheat cycles, double reheat cycles, combined cycles, as well as material on supercritical pressure and temperatures above those in use.

Thermische Turbomaschinen
Vol. I: Thermodynamisch-strömungstechnische Berechnung. By Walter Traupel. 1958, Springer-Verlag, Berlin, Germany. 407 p., 8 × 11 in., bound. 58.50 DM. Vol. 1 of a treatise on turbomachinery which is to cover steam turbines, gas turbines, and turbocompressors. The present volume on thermodynamic and fluid dynamic calculations provides a comprehensive treatment of the theory of heat engines, lays the groundwork for the design of single and multistage machines, and discusses special aspects such as shaft sealing, compensation for shear, performance under changed operating conditions, etc.

ASM-SLA Metallurgical Literature Classification
By The ASM Committee on Literature Classification. International (Second) Edition. 1958, American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio. 74 p., 8¾ × 11¼ in., ring binding. $3; work sheets $5. A revision of a classification system intended to provide a systematic and practical breakdown of the entire field of metallurgy, a uniform pattern for classifying serial and book publications of primary metallurgical interest, and a guide for setting up searching systems based on semiautomatic or machine methods, particularly the marginal punched card system. In this edition new headings and subdivisions have been added where substantial developments have occurred, and expansions have been made to provide greater depth of indexing in fields where experience has shown this to be desirable. The accompanying work sheets provide a means of expanding the classification and adapting it to individual situations.

ASTM Standards on Light Metals & Alloys
Sponsored by ASTM Committee B-7. 1958, American Society for Testing Materials, Philadelphia, Pa. 344 p., 6 × 9 in., paper. $4. This new edition contains the new color coding system for aluminum-base ingots as well as revisions made to 25 of the standards covering cast and wrought aluminum and magnesium and their alloys, aluminum wire and cable, and light metal die casting alloys.

American Power Conference Proceedings, Vol. XX
Published 1958, by Illinois Institute of Technology, Technology Center, Chicago, Ill. 748 p., 6¼ × 9¼ in., bound. $8. Papers dealing with varied aspects of the generation, transmission, and utilization of power. Among the topics discussed are steam and gas turbines, water technology; hydroelectric power; nuclear power development; industrial plants; central stations; transformers; extra-high voltage systems; distribution equipment; fuels; heating, ventilation, and air conditioning; computers and network analyzers.

Ball and Roller Bearings
By Paul Eschmann and others. 1958, K. G. Heyden and Company, Ltd., London, England. 375 p., 7 × 9¾ in., bound. $8.75. Translated from the German edition, this book represents the experience of a large ball and roller-bearing company. The types, materials, dimensions, and tolerances of the important bearings manufactured in Europe are presented. This is followed by a discussion of bearing stresses and kinematic phenomena with consideration of the basic relationships between carrying capacity, load, and life. A series of individual problems are then used to illustrate design principles and the practical aspects associated with them.

Chemical Processing of Nuclear Fuels
By F. S. Martin and G. L. Miles. 1958, Academic Press, Inc., New York, N. Y. 242 p., 5¾ × 8¾ in., bound. $7.50. An introduction to the problems of chemical processing of the fuel after it has been irradiated in a reactor. Following introductory materials, the major part of the book deals with aqueous processes, including solvent extraction, ion exchange, and precipitation processes; and with nonaqueous processe. including distillation of metals, extraction by liquid metals, fluoride volatilization, and separations based on chemical reactions. Concluding sections deal with effluent disposal and fission product recovery, and with trends in nuclear fuel processing.

Dynamics and Nonlinear Mechanics
By E. Leimanis and N. Minorsky. 1958, John Wiley & Sons, Inc., New York, N. Y. 206 p., 6 × 9¼ in., bound. $7.75. The first part of the book surveys modern analytical progress in the treatment of problems relating to the dynamics of rigid bodies and celestial mechanics. The second part outlines the current knowledge of the analysis of nonlinear oscillating systems and discusses general methods, methods of approximations, oscillations in nearly linear systems, and relaxation oscillations. Vol. 2 in "Surveys in Applied Mathematics."

Electronic Digital Computers
By Franz L. Alt. 1958, Academic Press, Inc., New York, N. Y. 336 p., 6¼ × 9¼ in., bound. $10. Intended for physicists, chemists, engineers, and others in similar fields who require the solution of computational problems by means of digital computing machines. The author deals mainly with the functioning, rather than the design, of computers, although some of the underlying physical principles are indicated. Following an introduction, the book covers automatic digital computers, coding and programming, problem analysis, and matching problems and machines.

The Engineer and Professional Management
By Harry Rubey. 1958, Lucas Brothers, Missouri Store Co., Columbia, Mo. 299 p., 9¼ × 11¼ in., ring binding. No price given. An introduction to management functions for the engineer beginning his career. The book is divided into two parts of which the first deals with such nonengineering functions as promotion, finance, professional management, organization, marketing, advertising, purchasing, and public relations. The second part deals with such semiengineering functions as managerial accounting and auditing, cost accounting and statistical control, estimating, valuation or appraisal, engineering economy, and industrial technologic research.

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Getriebetechnik und ihre Praktische Anwendung
Proceedings of the VDI Symposium, Constance, Switzerland, 1957. Published 1958, by VDI Verlag, Düsseldorf, Germany. 161 p., 8½ × 11¾ in., paper. No price given. The 24 papers in this compilation deal with various aspects of the practical use of mechanisms: the efficiency of power and motion transfer by mechanisms; automatic control devices; linkage problems and the use of charts for linkage analysis; practical design of drive mechanisms, and the use of models in design work; and a discussion of hydrostatic axial piston drives: This is VDI Berichte No. 29.

Glove Boxes and Shielded Cells for Handling Radioactive Materials
Edited by G. N. Walton. 1958, Academic Press, Inc., New York, N. Y. 515 p., 6¼ × 10 in., bound. $16.80. Papers dealing with radiation shielding which are based mainly on British practice. Part 1 is concerned with unshielded boxes and discusses safety. general design and manufacture, constructional materials, decontamination, layout in laboratories, provision of inert atmospheres, handling of polonium, operations with gaseous materials, and large scale operations. Part 2 deals with shielded cells and discusses shielding calculations, viewing and handling equipment, design of shielded cells as well as operations on beta-ray emitters, plutonium, multicurie caesium sources, and irradiated fissile materials. These papers comprise the proceedings of a Symposium held at Harwell, England, in 1957.

Hand In Hand
By The Hand in Hand Book Committee. 1958, Gordon and Co., 22 Harvard Avenue, West Medford, Mass. 337 p., 6¼ × 9¼ in., bound. $10. Following a brief survey of the co-operative engineering education program from its inception to the present, approximately three quarters of this book is devoted to biographical sketches of those engineers who have participated in this program.

Handbuch der Spannungs- und Dehnungsmessung
Edited by Kurt Fink and Christof Rohrbach. 1958, VDI-Verlag, Düsseldorf, Germany. 513 p., 6¼ × 8½ in., bound. 68.50 DM. This handbook on stress and strain measurement provides a comprehensive treatment of the subject. The 14 sections cover the following topics: The possibilities and limits of experimental determination of states of stress and their interpretation; stress measurement by optical methods, x rays, brittle lacquer, mechanical and pneumatic gages, and wire strain gages; calibration of strain gages; selection of suitable measurement procedures; model technology.

Mathematical Aspects of Subsonic and Transonic Gas Dynamics
By Lipman Bers. 1958, John Wiley & Sons, Inc., New York, N. Y. 164 p., 6 × 9¼ in., bound. $7.75. The author is concerned with a limited part of the theory of compressible fluid flow: two-dimensional steady potential flows. Mathematical methods are emphasized rather than the physical problems themselves, and the "applications" of fluid dynamics as a source of mathematical concepts are stressed. Particular attention is paid to existence and uniqueness questions for subsonic and transonic flow problems. Vol. 3 in "Surveys in Applied Mathematics."

National Conference on the Administration of Research Proceedings
Published 1958 by the Pennsylvania State University Press, University Park, Pa. 163 p., 8½ × 10¾ in., paper, $4.50. Proceedings of the 11th Conference held in 1957, dealing with the management of scientific and engineering research and with the utilization and career planning of technically trained personnel. Beginning with discussions on creativity, the book continues with the attitudes and motivations of scientists and engineers toward their jobs, measurement of research accomplishment, the size of research and engineering teams, administrative attitudes toward basic research, and studies on basic research in the United States, Europe, and Russia.

Operations Research for Industrial Management
By Dimitris N. Chorafas. 1958, Reinhold Publishing Corp., New York, N. Y. 303 p., 6¼ × 9¼ in., bound. $8.75. Presents recently developed operations research techniques used for executive decision making with emphasis on simulation studies. The application of operations research methods is considered in relation to financial allocation, transportation problems, inventory control, and production setups. Descriptions are also given for game theory, linear programming, flow techniques, and matrix algebra. The use of electronic computers in relation to operations research is discussed.

Rocketry and Space Exploration
By Andrew G. Haley. 1958, D. Van Nostrand Company, Inc., Princeton, N. J. 334 p., 7 × 10¼ in., bound. $6.75. Following a brief, nontechnical explanation of the operation of rockets, a complete history of their development is given. The book begins with the origins of rocketry in the 1930's and continues with the Axis war rockets of World War II, and such postwar developments as the Atlas, Titan, Thor, Nike, X-15, Sputniks, Vanguard, and Explorers. Concluding chapters deal with the efforts made toward international co-operation in astronautics, and with the work of such societies as the American Rocket Society and the British Interplanetary Society.

Tools for Machine Literature Searching
By J. W. Perry and Allen Kent. 1958, Interscience Publishers, Inc., New York, N. Y. 972 p., 6¼ × 9¼ in., bound. $27.50. An extensive work which represents the results of a considerable amount of experimentation over the past five years. The book is presented in four parts, of which the first two deal with machine literature searching systems in general and their basic underlying principles. In the third part, procedures

developed by the authors are given for analyzing, encoding, and searching of recorded information. The concluding section consists of a semantic code dictionary with directions for its use.

Uranium and Thorium
By L. Grainger. 1958, Pitman Publishing Company, New York, N. Y. 204 p., 5½ × 8¾ in., bound. $6. A study of interest to those dealing with fissionable materials, which summarizes and attempts to make clear some of the recent material published on the subject of uranium and thorium. Aspects covered are occurrence and extraction, chemical and physical properties, health hazards, and use as nuclear fuels. A concluding section discusses current practice and the future possibilities of fuel elements.

Advanced Mechanics of Fluids
Edited by Hunter Rouse. 1959, John Wiley & Sons, Inc., New York, N. Y. 444 p., 6 × 9¼ in., bound. $9.75. An advanced sequel to the editor's earlier work, "Elementary Mechanics of Fluids." The goal of the present volume is the development of research methods, therefore the theoretical approach is given primary emphasis. Among the topics discussed are irrotational flow, conformal representation of two-dimensional flow, laminar motion, turbulence, boundary layers, and free-turbulence shear flow.

American Society of Tool Engineers, Collected Papers, 1958
Published 1958 by the American Society of Tool Engineers, Detroit, Mich. Two volumes, 8¾ × 11¼ in., loose-leaf. No price given. Papers covering a wide variety of topics relating to tool engineering. Aspects covered include metal cutting, plastic tooling, cutting tools, numerical control, metal powder parts, automation, fabricating processes, tooling design, metal forming, engineering materials, and quality control.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting April 17, 1959, and approved by the Board on June 4, 1959.)

Erratum

Interpretations, May, 1959, last paragraph, revise Jan. 9, 1958, and March 5, 1958, to read Jan. 9, 1959, and March 5, 1959.

Annulment of Cases

Case No.	Reasons for Annulment
1110-2	Revision to Case No. 1223-1 permits annulment of this Case
1224-1	Included in Case 1270N
1225	1271N
1226-3	1272N
1228	1272N
1234	1273N
1235	1271N
1238	1272N
1245	1271N
1260	1273N
1264	1274N

Case 1124-2
(Reopened) (Special Ruling)
(Use of Electric Resistance-Welded Pipe)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use electric-resistance-welded pipe conforming to the requirements of Specification SA-135 except that the chemical and tensile requirements are as follows:

CHEMICAL REQUIREMENTS	PER CENT
Carbon, max	0.30
Manganese	0.35 to 1.25
Phosphorus, max	0.045
Sulfur, max	0.06
TENSILE REQUIREMENTS	
Tensile strength, min, psi	75,000
Yield strength, min, psi	45,000
Elongation in 2 in., min, per cent	20

Reply: It is the opinion of the committee that the material specified in the Inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII of the Code provided the following additional requirements are complied with:

(1) The maximum operating temperature shall not exceed 650 F.

(2) The maximum allowable stress value shall be 15,950 psi.

(3) The thickness shall not exceed 0.58 in. and the diameter shall not exceed 30 in.

(4) When the process of manufacture of the pipe does not require crop ends, the flattening test specimens shall be taken from the same pipe as the tensile specimens are taken, and the number of lengths of pipe to be examined shall be the number specified for the tension test.

(5) The requirements for welding in Section IX shall be the same as for Specification SA-135, Grade B.

Case 1184
(Special Ruling)
(Wrought Nickel-Chrome-Moly)

Revise reference to specifications to read SB-169 and SB-111.

Case 1196
(Special Ruling)
(Aluminum Bronze Alloy, Centrifugal Cast)

Revise reference to specification ASTM B 271-52T to read ASTM B 271-54.

Case 1200
(Special Ruling)
(Wrought Iron Plates, A 42-52T)

Revise reference to specification to read ASTM A 42-58.

Case 1258-1
(Reopened)(Special Ruling)
(Use of Unalloyed Titanium)

Inquiry: Revise the last sentence to read:

Grades 1, 2, and 3 are submitted for internal pressure applications, and Grade 3 only is submitted for external pressure applications.

Reply: Revise the following:

Par. (4) In the first sentence add "in tension" after stress values."

Add a new Par. (5) as follows, and renumber the present (5) as (6).

(5) *External Pressure*

(a) The required thickness of shells or heads made of Grade 3 shall be determined from the chart in Fig. UNF-28.22.

(b) The required moment of inertia of stiffening rings shall be determined from the appropriate chart in the Code for the material used in the ring or from Fig. UNF-28.22 if made of Grade 3 unalloyed titanium.

FIG. UNF-28.22 Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Unalloyed Titanium, Grade 3, is included with case sheets.

Case 1270N

(Special Ruling)

(General Requirements for Nuclear Vessels)

Inquiry: Neither Section I nor Section VIII of the ASME Boiler and Pressure Vessel Code as now written precisely covers pressure vessels that are an integral part of a nuclear installation. Under what rules shall they be constructed?

Reply: The Committee recognizes that in the design of nuclear installations, some requirements will differ from those of conventional boilers and pressure vessels.

(1) It is the opinion of the Committee that vessels that are an integral part of nuclear installations built in accordance with the requirements of the ASME Boiler and Pressure Vessel Code as modified or defined in this case and subsequent cases designated by the suffix "N" after the Case number meet the intent of the Code, and each vessel shall be marked as required by the section to which it is built including the appropriate Code Symbol. In addition, the words "Case No. 1270N" shall appear on the Data Report for all vessels built under this and subsequent cases dealing with nuclear vessels.

(2) All vessels that are an integral part of nuclear installations shall be constructed in accordance either with the requirements of Section I or else with the requirements of Section VIII, except as these requirements are specifically modified in this and subsequent cases dealing with nuclear vessels.

(3) All longitudinal and circumferential welded joints of vessels defined in 5(a), (b), and (d), built under this and subsequent cases dealing with nuclear vessels shall be of the double welded butt type or its equivalent and shall be fully radiographed, and the vessel shall be stress-relieved in all thicknesses.

(4) It is intended that jurisdiction over piping external to vessels shall terminate at:

(a) The first circumferential joint for welding end connections: or,

(b) The face of the first flange in bolted flange connections: or,

(c) The first threaded joint in that type of connection.

(5) Definitions

(a) The Reactor Vessel is that vessel in which nuclear fuel is present and in which the nuclear chain reaction takes place.

(b) Primary Vessels are those vessels, other than the reactor and containment vessels, which are designed to contain reactor coolant. These vessels may be heat-exchangers, pressurizer tanks, drain tanks, dewatering vessels, etc.

(c) Secondary vessels are all other vessels which do not contain reactor coolant or are not otherwise subject to irradiation. Secondary vessels are covered in appropriate sections of the Code.

(d) Containment Vessels are those outer vessels which enclose the reactor vessel or portions of the primary coolant circuit or both. The containment vessels are not normally pressurized and are built to contain the lethal radioactive substances that may be released in case of an accident or failure of the reactor vessel or the primary coolant circuit or both.

(e) Intermediate Containment Vessels are those vessels within the containment vessel which enclose a portion or all of the primary reactor vessel. The intermediate containment vessels may or may not be pressurized during normal operation but they are intended to contain the primary coolant that may be released in case of an accident or failure of the vessel which they enclose.

Case 1271N

(Special Ruling)

(Safety Devices)

Inquiry: Various safety requirements of Section I and Section VIII of the Code would actually be hazardous if applied literally to the design of nuclear vessels. What modifications may be made in the requirements for safety devices on such vessels?

Reply: It is the opinion of the Committee that the following modifications may be made in the requirements for the types of nuclear vessels specified to avoid the hazards that would result from a literal application of the safety requirements specified for boilers and pressure vessels in Section I and Section VIII.

(1) *Pressurized Water and Boiling Water Reactors:* The following provisions apply to reactors of the pressurized-water and boiling-water types:

(a) Totally enclosed pop-type safety or relief valves shall be provided, but need not be directly attached to the vessel provided there is no valve between the vessel and the safety or relief valve: also they shall be installed as close as is practical to the vessel. They shall not discharge to the atmosphere and shall discharge to a suitable system designed to condense any vapors. At least two safety or relief valves are required and the total capacity shall be sufficient to insure that the design pressure is not exceeded by more than 10 per cent.

(b) Direct reading pressure gauges are not required. At least two independent devices for determining pressure are required and these shall not be dependent on the same source of external energy.

(c) Inspection openings, gage glasses, water columns, and gage cocks are not required.

(2) *Containment Vessels:* Because of the hazardous nature of the material that might be released, pressure relief devices are not required on containment vessels designed and built to safely contain all the radioactive substances that may be released in case of a maximum credible accident affecting the reactor vessel, the primary coolant circuit, or both. If for any reason such devices are installed, adequate provision shall be made for safe disposal of the effluent.

(3) *Rupture Disks:* A low-pressure rupture disk may be used in the discharge pipe immediately adjacent to the steam safety valve outlet in a nulcear system to prevent atmospheric pollution in the containment vessel which might result from small intermittent or persistent safety valve leakage provided the following requirements are met:

(a) The rupture disk shall be designed to burst at a maximum of 13 psi, including manufacturing tolerances.

(b) The safety valve settings are reduced so that the valve setting plus 13 psi shall not exceed the design pressure of the reactor or its steam separating drum.

(c) The internal diameter of the disk holder shall at least be equal to that of the safety valve discharge connection so that when the disk bursts there will be no restriction on the safety valve discharge.

(d) The rupture disk holder shall be designed to include a 1-in. drain opening on its inlet side. This drain opening shall be coupled to the required drain opening at the lowest point in the outlet of the safety valve body. The combined drains shall be piped to a suitable drain tank.

Case 1272N

(Special Ruling)

(Containment and Intermediate Containment Vessels)

Inquiry: Under what variations from Case No. 1270N and the rules of Section VIII may containment vessels and intermediate containment vessels, as defined in Case No. 1270N, be built and be acceptable as meeting the requirements of the Code?

Reply: It is the opinion of the Committee that containment and intermediate

containment vessels meet the intent of the Code and shall be marked in accordance with Case No. 1270N provided the following requirements are met:

(1) *Stress Relief of Containment Vessels:* The requirement for stress relieving in all thicknesses given in Par. (3) of the Reply to Case 1270 N iswaived for containment vessels provided the following are met:

(a) Plates and forgings of containment vessels exposed to the elements (not inside a heated enclosure) shall conform to specifications SA-300 for plates and SA-350 for forgings. These and other materials and the construction shall meet the impact test requirements of Par. UG-84 at a temperature not less than 30 F below the lowest recorded ambient temperature of the area in which the containment vessel is to be erected, except that the lowest test temperature may be assumed to be −50 F for any part in the United States.

(b) All doors, nozzles, and opening frames shall be preassembled into shell plate and stress relieved as complete assemblies for welding into the shell. Also, special consideration should be given to make the design of the reinforcement for large openings as strong as the shell (see Par. UA-7).

(c) The thickness of the shell and head plate shall not exceed that for which stress-relieving is required in accordance with Par. UCS-56, except that for materials listed under group P-number 1 in Table UCS-23, stress-relieving is not required in thicknesses over $1\frac{1}{4}$ in., and up to $1\frac{1}{2}$ in., inclusive, provided a preheat of 200 F is used during welding.

(d) All welds on doors, nozzles, and opening frames, and all welds that cannot be radiographed shall be examined for cracks by magnetic particle or fluid penetrant method of inspection.

(2) *Intermediate Containment Vessels:* For intermediate containment vessels surrounding the reactor vessel, that are not required to contain radioactive materials under normal operating conditions, the special requirements given in Par. (3) of Case 1270N are waived, except as otherwise required by Section VIII of the Code. For all other intermediate containment vessels the requirements for stress-relieving given in Par. (3) of Case 1270N is waived provided the requirements of Par. (1) of this Case, omitting subparagraph (a), are met.

(3) *Corrosion:* Provisions for corrosion shall be made in accordance with Par. UG-25. The mandatory requirements of Par. UCS-25 are not intended to apply to containment and intermediate containment vessels.

(4) *Two-Stage Construction:* Inspection of welded joints in the lower part of containment vessels during the pneumatic test will be waived where such joints are covered by concrete during the construction of the vessel, provided:

(a) There are no openings or penetrations of the part of the vessel covered by concrete, and

(b) All welds that are inaccessible for inspection during the test of the completed vessel are of the double butt type, are fully radiographed, and are tested for leak tightness using a gas medium such as Halide Leak Detector Test prior to being covered.

Case 1273N

(Special Ruling)

(Nuclear Reactor Vessels and Primary Vessels)

Inquiry: Under what special rules shall a nuclear reactor vessel or a primary vessel, as defined in Case No. 1270N, be built in order to be acceptable for Code construction?

Reply: Pending development of more complete rules to cover nuclear vessels, it is the opinion of the Committee that a reactor vessel or a primary vessel shall meet the requirements of this Case in order to meet the intent of the Code and to be stamped in accordance with Case No. 1270N. Where differences exist the requirements of this Case take precedence over the Code rules for the subjects covered. The requirements of this Case are:

(1) The thickness of each part of the vessel shall not be less than that determined by the Code rules using the applicable formula for the part with S values from the appropriate table in Sections I or VIII.

(2) The combination of stresses evaluated under item (1) with thermal stresses due to temperature distributions at any level of steady power operation, including internal heat generation, shall not exceed $1\frac{1}{2}$ times the S value.

(3) For operating metal temperatures up to 800 F the maximum allowable bolt design stresses as used in Code formulas may be based on heat-treated properties for operating metal temperatures 100 F or more below the tempering temperature, provided the stresses do not exceed $\frac{1}{3}$ of the yield strength at temperature.

(4) Due regard shall be given to the creep and stress-rupture properties for prolonged exposure at temperature in order to assure adequate safety under all conditions of operation.

(5) (a) Compensation shall be made for all openings, regardless of diameter. The compensation shall be on either the reinforcement basis or the ligament efficiency basis as given in Sections I or VIII. Any compensation required shall be integral with the vessel wall or the nozzle or some with each.

(b) When all or part of the required compensation is attributable to the nozzle, the nozzle shall be attached by full penetration welds through either the vessel or the nozzle thickness. When no portion of the nozzle is required for opening compensation, the nozzle need not be attached by full penetration welds, except as limited by (d).

(c) Each design detail shall be carefully considered to provide against operational failure such as might occur from thermal stress or external pipe reactions.

(d) It is the intent of the foregoing that full penetration welds be used wherever possible, for the purpose of achieving continuity of metal and facilitating the required radiographic examination. Non-full penetration welds are intended to be allowed only when the spacing of the openings is such as to make the achievement of full penetration welds through the vessel or nozzle walls physically impossible.

(6) All welds which are subject to stress caused by pressure shall be radiographically inspected, except where this is impractical for non-full-penetration welds at close-spaced openings as permitted in item (5). Wherever possible all weld joints shall be designed to permit radiographic examination to Code standards. When the weld joints cannot be designed to permit radiography to Code standards, radiographic examination shall nevertheless be made in accordance with best obtainable practice. In addition, when radiography to Code standards is not feasible or when any radiography is impractical, welds shall be examined by other nondestructive methods such as liquid penetrant, magnetic particle, or ultrasonic, to prove their soundness. None of this item applies to seal welds.

(7) The Code rules are intended to provide minimum safety requirements for new construction, and not to cover deterioration which may occur in service as a result of corrosion, erosion, radiation effects, instability of the material, or operating conditions such as transient thermal stress or mechanical shock and vibratory loading; nevertheless particular consideration shall be given to these effects with a view to obtaining the desired life of the vessel.

(8) In view of these severe service requirements, particular consideration shall also be given to materials, construction, and inspection, including supplementary methods of non-destructive testing, so that soundness and good practice will result. Due regard shall be given to such items as smoothness of welds and to loca-

tion and detail of structural attachments.

(9) When the surface exposed to the fluid under pressure is required to be clad with a material having better corrosion resistance than the base metal, the rules of Part UCL of Section VIII governing application of cladding shall apply except as modified below and the applicable design formulas from Section I or Section VIII may be used with the following supplementary rule:

(a) The specified nominal thickness of the cladding shall not be included as a part of the required wall thickness. In applying the design formula the diameter shall be taken as the inside diameter plus twice the specified nominal thickness of the cladding.

Case 1274N
(Special Ruling)
(Special Material Requirements)

Inquiry: What special materials not listed as materials adopted for Code construction may be used in nuclear pressure vessels conforming to the requirements of Section I or Section VIII of the Code as supplemented by Case 1273N?

Reply: It is the opinion of the Committee that the following special materials may be used for the construction of nuclear vessels under rules of Section I or Section VIII of the Code as supplemented by Case 1273N.

(1) Seamless steel forgings or bars (AISI—Type 403 Modified) conforming to the following chemical analysis, having minimum specified mechanical properties shown below, and complying with the specified additional requirements, may be used in the construction.

(a) *Chemistry* (AISI—Type 403 Modified)

	PER CENT
Carbon	0.06 to 0.13
Manganese	0.25 to 0.80
Phosphorus, max	0.03
Sulfur, max	0.03
Chromium	11.50 to 13.00
Nickel, max	0.50
Silicon, max	0.50

(b) Mechanical properties in the annealed condition as received conform to the following requirements.

Tensile strength, psi, min	70,000
Yield strength, psi, min	40,000
Elongation in 2 in., per cent, min	22.0
Reduction of area, per cent, min	50.0

(c) Mechanical properties after a heat-treatment consisting of heating to 1775 to 1825 F followed by air cooling, or quenching in a salt bath at 1025 to 1075 F and air cooled, and then tempered at 1125 F minimum for four (4) hours conform to the following requirements:

Tensile strength, psi, min	110,000
Yield strength, psi, min	90,000
Elongation in 2 in., per cent, min	16.0
Reduction of area, per cent, min	50.0
Rockwell C hardness	22 to 29
Brinell hardness	235 to 277

(d) The material shall conform to all other requirements of SA-182 Grade F6 for forgings, and ASTM A 276 for bars.

(e) The maximum inside diameter of the shell is 8 in.

(f) The maximum operating temperature shall not exceed 650 F.

(g) Allowable stresses as shown in Table 1 below for the heat-treated condition may be used when the material has enhanced properties due to the special heat-treatment described in the Inquiry.

(h) Where the method of fabrication requires welding after heat-treatment, it shall be done by applying austenitic chromium-nickel steel or chromium-nickel weld deposits prior to heat-treatment and only on regions designed to the allowable stresses shown in Table 1 below for annealed properties. The minimum thickness of this weld shall be $^3/_{16}$ in. and the maximum $^1/_2$ in. Such weld deposits shall be liquid penetrant inspected. Attachments to these austenitic weld deposits may be made by austenitic welding subsequent to heat-treatment, and the thickness shall not exceed that of the previously deposited weld. No welding on the ferritic base metal is permitted after heat-treatment and no welding is permitted at any time in the regions designed to allowable stresses higher than those given in Table I for annealed properties. All welding shall meet the requirements of Section IX, except that the tests shall be made after final heat-treatment of the specimen and longitudinal bend test specimen of Part B, Section IX, may be used.

(i) Machined transitions between adjoining heavy and thin walled sections shall consist of a taper of at least 4 to 1, with a radius at each end of at least twice the thickness of the thin wall.

(j) All heat-treated parts shall be inspected for quench cracks by a liquid penetrant method. All cracks shall be removed and a crack which cannot be removed within the minimum required thickness of the shell is cause for rejection.

(k) Hardness checks shall be made after heat-treatment at not more than 5 foot intervals with a minimum of three different locations representing approximately the center and each end. The average of individual hardness readings at each location shall not be less than 235 Brinell nor more than 277 Brinell.

TABLE 1—ALLOWABLE STRESSES, PSI

	−20 to 100 F	300 F	500 F	650 F
Heat-treated	27,500	24,750	23,350	22,000
Annealed	17,500	16,380	15,100	14,300

Note: It is anticipated that this material is intended for severe services requiring premium quality materials. The above represent minimum requirements and the design engineer is expected to require such additional requirements for design, material testing, and fabrication inspection as is considered necessary to meet the demands of the intended service.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the semi-annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1959

TABLE A-11, Minimum Metal Thickness of Bodies of Cast-Iron Malleable-Iron, and Bronze Screwed Fittings Revise the reference to read:

(The following table is taken from ASA B16.4-1949, B16.3-1951, B16.19-1951, B16.16-1958, and B16.17-1949)

Unfired Pressure Vessels, 1956

PAR. UHA-32 Add the following paragraph as (b) and renumber present (b) to (c); (c) to (d); (d) to (e), and (e) to (f).

(b) Ferritic steel parts of austenitic chromium-nickel stainless steel vessels shall not be subjected to the solution heat-treatment described in Par. UHA-105(b).

PAR. UHA-32(c) Revise as follows: (Also change this paragraph (c) to read (d) as noted above.)

(d) When Type 405 and Type 410S in plate thicknesses not exceeding $^3/_8$ in. are welded with austenitic electrodes, stress-relieving or other heat-treatment is neither mandatory nor prohibited. For heavier thickness stress-relieving is required, except that for thicknesses over $^3/_8$ in. and up to and including $1^1/_2$ in. stress-relieving need not be performed provided the joints are completely radiographed, and provided a preheat of 450 F minimum is maintained during welding.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

U. S. Students to Have On-the-Job Training Under IAESTE in 14 European Countries

What is IAESTE, how does it function, how to apply

NEARLY 100 engineering and science students from 39 colleges and universities in the U. S. will spend from eight to 12 weeks on on-the-job training in foreign industry this summer. At the same time, 70 students from foreign countries will work in 50 companies in this country.

What is IAESTE?

IAESTE means International Association for the Exchange of Students for Technical Experience. It is a nongovernmental, nonprofit organization founded at London University's Imperial College in 1948. Its initial ten Western European member countries began the program in 1948 with an exchange of 920 students. At the close of 1958, just under 40,000 students had been exhanged, between 26 member countries.

The Association is closely allied with the Committee on International Relations of the Engineers Joint Council.

American participation started in 1955. Josef Wischeidt, Jr., of the EJC, is executive secretary for U. S. IAESTE Committee, which means he attends the annual conference (January) at which the exchanges are arranged. This past January, he had with him only 55 jobs to offer. The German delegate, making a speech of welcome to the newly admitted Tunisian delegate, could say, "I offer 30 job opportunities for Tunisian students in Germany." Those Tunisian students will become familiar with German industry, and may one day order German engineering products. Altogether, Germany finds places for 1400 visiting students; Sweden 1000; Britain 900.

A chartered plane carrying 60 of our students left for Europe on Saturday, June 13, and will return September 10, giving most of the students at least a week for general travel in Europe. A student pays his own travel expenses, and receives sufficient pay for his work to cover living expenses—and, in most cases, a little more. Exchange students in America usually receive $325 to $350 per month.

How to Apply

Students obtain applications through the IAESTE adviser on campus, and the application must be on file with Mr. Wischeidt at the EJC office, 29 West 39th Street, New York 18, N. Y., not later than December 31. Applicants thus have their chance in the annual matching of students and jobs, which takes place in January. An applicant must be a technical student, and he must show that he is going to continue his studies after he returns from his summer with the foreign engineering firm.

This year's students from American colleges and engineering schools will train in 14 European countries, including Austria, Denmark, Finland, France, Germany, Great Britain, Israel, Italy, the Netherlands, Norway, Sweden, Switzerland, and Turkey. Mechanical-engineering students are the largest segment of the group, with chemical and electrical engineers next.

Among those leaving on the plane June 13 was Karl D. Lilje, Assoc. Mem. ASME. Mr. Lilje took his BS at Penn State, and is currently working toward his MS at NYU. He is also teaching kinematics and machine design at NYU. He was headed for Switzerland, where he would work for Brown Boveri, doing "test work on controls for power plants." Whether this meant production or experimental work, he wasn't sure. As with all the other successful applicants, his qualifications were reasonably well matched to the job. Also, it is a great advantage if the prospective trainee knows the language of the country to which he might be sent. Many foreign firms find that too much is lost if the visitor cannot read technical writings in the native language.

However, foreign plants have people who can speak English. And most foreign students who come over here are themselves quite competent in English.

On-the-Job Training Program

The program does not include any courses of study: It is strictly on-the-job training. Exchanges are supposed to be on a one-to-one basis, but foreign firms have shown a willingness to take more of our students than we can accept of theirs. It is taking time for us to develop the necessary program in industry. Firms that have already participated have been pleased with the foreign students, who are potential leaders in their own countries and whose international experience builds a foundation for understanding and good will.

Students who have been abroad in previous years report that Europe seems to take its young people more seriously than we do here in the United States. They devote more thought to their student engineers. At least one American firm (General Electric) reports that European students are superior on general applications of science, while American students are better in specialized fields. The exchange program provides an opportunity to compare the educational output of the 26 participating countries.

Commenting on IAESTE, Maynard M. Boring had this to say,

> **"Here is a most positive means of providing a more rounded background for student engineers. The IAESTE program has immense potential at a time when this country suffers from a critical shortage of engineers and is looking for new and improved training methods for its engineering students. American business has much to offer and much to gain from IAESTE."**

Mr. Boring, a Member of ASME, is manager of Technical Personnel Services of the General Electric Company.

SBME Hears President Eisenhower Call for Sound, Healthy Economy

It was a dramatic moment for J. J. Jaklitsch, Jr., Editor ASME, as he and 82 other members of the Society of Business Magazine Editors ambled up to the White House gates on the morning of June 4, got checked through by the guards, and were ushered into the White House office. The event: A conference with Dwight D. Eisenhower, President of the United States—his first with members of SBME. And according to his report it was a memorable occasion.

Colin Carmichael, Mem. ASME, Editor of *Machine Design*, and this year's president of SBME, in presenting the group to the President briefly described the SBME and its activities, pointing out that its member magazines serving the industrial, marketing, and technical fields of American business reach between 6 and 7 million readers.

Not only did the President charm the editors with his off-the-cuff talk, but he brought to them a sound message.

Said he: "The great base today on which America must stand is a sound, expanding, healthy, and vigorous economy. We must have an enlightened, informed public opinion.... We must recognize their value not only to us but our standing in the world, including our security from any threatened attack, no matter of what character."

To illustrate his philosophy the President gave a warm reminiscent account of his financial problems as a young man.

"When I was a boy," he continued, "it was thought we could live our lives on a little piece of ground in the West, and the older folks—grandfather and grandmother—could live in the same home, after their days of hard work were ended. That's the way we took care of ourselves and our older people. Today, through the changes in our industrial system, we as a people have become dependent for old-age security, more and more upon pensions, insurance policies, savings bonds, and savings accounts. These are the people that are particularly hurt by depreciation of the dollar.

"People who get a dollar one year and spend it that or the next year are not as much hurt even if there develops a sort of creeping inflation, or cheapening of the dollar. But the man who makes a living today and puts away his savings to be used 40 years from now can receive some startling lessons over that 40-year period.

"My wife and I decided, in 1916, to get married. Since I, like all other Second Lieutenants, was always overdrawn at the bank, I decided that I ought to show a little more sense of responsibility. So I began to buy a small insurance policy.

"Well, I gave up smoking ready-made cigarettes and went to Bull Durham and the papers. I had to make a great many sacrifices to buy that small insurance policy. Then thirty years later the company came around to pay it off. And I had even forgotten about it. It was so small that I would have been ashamed to ask my wife to exist on it for six months.

"Yet, I still think of the fun we had in working for our own future. Indeed, it was easy to make little sacrifices because I was young and of course very much in love.

"But today, think of the man at the lathe, the drill press, who is earning money which he is putting away in his pension with his company or into an insurance policy. If we today cannot assure him that forty years from now he is going to be able to have a good living left, then I say, sooner or later, he will quit buying insurance policies; he will not have any confidence in the government bond; and he will not think very much of his pension.

"These are some of the facts that I think you people know about and undoubtedly you teach them. But I think we don't teach them strongly enough.

"Our economy, if it is going to be competitive and a free economy, must be just that. It's the only way we are going to be strong and expanding. If we are going to live as a free people, we must not be controlled people, and we must not start controlling prices in times of peace.

"We are living in a time of prosperity that looks like it is assuming boom proportions. If now, today, we can't pay off some of the Federal debt, then our financing is going to have to be done under very unsatisfactory methods, to the damage of all of us. In the long run there will be inflation, there will be a further cheapening of our money, and it won't be the rich that will be suffering. Instead it will be all those millions who, with their hands and brains, typewriters, shovels, and all the rest, are producing the wealth of the United States, and depending upon insurance and pension plans for old-age security.

"So as I leave you, I thank you for your patience in listening to a very homey exposition of some of my own views and convictions on this subject. They may not be erudite but are earnest and firm."

8.3 Per Cent Rise in U. S. Engineering Teachers' Income Reported

United States engineering teachers' average professional income has risen 8.3 per cent since 1956, and their basic teaching salaries have increased 13.5 per cent over the two-year period according to a survey recently published for Engineers Joint Council.

The survey included close to 5000 engineering teachers, or about half of those in all our engineering colleges. The questionnaires were secured last year by Engineering Manpower Commission as a part of the survey on "Professional Income of Engineers." The present report includes an extensive analysis of total professional income and teaching salaries by geographic area, type of institution, academic rank, highest earned degree, and was made possible by a grant to EMC by the National Science Foundation.

The average professional income in 1958 was $9598, up 8.3 per cent in two years. The increase was due to rising teaching salaries (up 13.5 per cent) since outside income actually declined due primarily to reduction of consulting opportunities during the 1957–1958 recession period. Largest gain was in the private institutions. Lowest incomes were reported from the South and highest from the Pacific area.

The full report, "Salaries and Income of Engineering Teachers, 1958," is available from the Engineers Joint Council, 29 West 39th Street, New York 18, N. Y., for twenty-five cents a copy to cover handling and mailing charges.

MEETINGS OF OTHER SOCIETIES

Aug. 5–8

William F. Durand Centennial Conference, Stanford University, Stanford, Calif.

Aug. 10–13

Society of Automotive Engineers, national west coast meeting, Hotel Georgia, Vancouver, B. C.

Aug. 17–21

Technical Association of the Pulp and Paper Industry, testing conference, Multnomah Hotel, Portland, Ore.

Aug. 19–26

International Institute of Refrigeration. international congress, Copenhagen, Denmark.

(For ASME Coming Events, see page 111)

Technical session: J. A. Duffie, U. of Wisconsin, speaking. The major work in solar energy is done in the universities.

Advances in Applied Solar Energy Surveyed During New York Meeting

THE Association for Applied Solar Energy held its 1959 annual meeting at New York University, May 26–28, bringing together top research scientists and engineers who are working together toward the utilization of solar energy.

The four-year-old association, which has its headquarters in Phoenix, Ariz., includes among its leading members most of the top men in ASME's Solar Energy Application Committee. Our Committee was organized in 1956. Among the ASME men who took part in the Association's conference were E. A. Farber of the University of Florida (he is secretary of our Committee), F. C. Edlin of du Pont, P. E. Glaser of Arthur D. Little, Inc., H. C. Hottel of M.I.T., R. C. Jordan of the University of Minnesota, and W. T. Lucking, president of the Arizona Public Service Company, Phoenix, Ariz.

Another ASME Committee Member who took part was a woman scientist, Dr. Maria Telkes of Curtiss-Wright Corporation.

New York University and Stanford Research Institute joined the Association for Applied Solar Energy in sponsoring this conference. The meetings were held at the New York University Club in mid-Manhattan, near the Main Public Library, on the steps of which Dr. Telkes once demonstrated the possibilities of cooking by solar energy. It is the recollection, here, that she fried eggs in a solar cooker.

Attending the conference were engineers from Israel, Australia, and Japan.

A representative of the U. S. Weather Bureau was on hand, as was a representative from the United Nations.

Free but Expensive

Every hour, the sun delivers more energy to the earth than man can use in a year. But it is elusive: Trapping it, storing it, and using it are problems that are taxing the ingenuity of heat engineers.

Speaking at the banquet, Dr. Farrington Daniels of the University of Wisconsin put it quite simply: "Sunlight is free, but it costs a lot of money to collect it. The prospect of cheap electricity from sunlight is dim. The hope is to help the nonindustrialized nations which lack the fossil fuels."

So far, the one widely used application of solar energy in the U. S. has been the home water heater so prevalent in Florida. Deficiencies of such heaters have not been in the solar collector, but rather in the failure to provide sufficient tank capacity. Methods for both the heating and cooling of homes are now under investigation. The solar distilling of sea water to provide drinking water for sizable communities will soon be a fact, and the solar furnace now provides extremely high temperatures, without contaminating gases, for high-temperature research. The solar generation of electrical energy is not yet here on any large scale, an immediate problem being an efficient method for storing the energy.

The technical sessions took the form of panel discussions. Following a speech of welcome by Dr. John Nielsen, Research Co-ordinator of NYU's College of Engineering, the first session got under way with Dr. A. J. Drummond of Eppley Laboratories as moderator. The session heard and discussed reports from Dr. Harry Tabor, Director of the National Physical Laboratory of Israel, and from Drs. J. A. Duffie of the University of Wisconsin, H. C. Hottel of M.I.T., and R. C. Jordan, University of Minnesota. The major work in the study of solar energy applications is being done by universities around the world.

World Sunshine Map

Dr. Tabor reported on the Geneva meeting called in February at the request of UNESCO, at which steps were taken to collect data for a world sunshine map, comparable to the U. S. Weather Bureau's sunshine map for this country. Professor Duffie presented a number of ideas—and hopes—on collector systems. Professor Hottel reported on the work of the Chemical Engineering Department at M.I.T. on "selective black surfaces," which enable the flat-plate collector to pick up a maximum of solar energy, making it competitive with the focussing collector. Professor Jordan spoke on developments at the University of Minnesota in the use of solar radiation for drying.

At an informal discussion, Dr. Tabor reported that Israel solar heaters are producing steam for the processing of food, and for various manufacturing processes such as the making of paper. Israel's engineers are designing a power package that will give the farmer a unit of one to ten hp for the pumping of water and other chores— and for the desalination of salt

water. They expect this power package to fill a need in places that cannot be reached by power lines. It might find a considerable market in Australia.

He expects the next major development to be the cooling of homes by solar energy, using the absorption-refrigeration principle.

"In cooling a house," he said, "at least you have the sun when you want it. In heating, you need the sun just when you haven't got it."

A major problem is the storing of energy for use when the sun is not available. In Israel they have a research group working on heat storage, investigating all the physical-chemical systems that seem possible for the storage of heat.

There is the possible use of large bodies of water as collectors. Attempts to take advantage of the temperature differential between the surface and the water below have failed, as far as the sea is concerned. But experiments show the possibility of building a large pond in which heat collects on the bottom and stays there because a substance dissolved in the water impedes convection. The water at the bottom may be as much as 60 F higher than the top, a considerable reservoir of heat energy. There is loss to the bottom—the earth—but the real problem is how to extract the heat without disturbing the stability of the nonconvective solution.

Heat for the Home

The second session heard from Dr. George O. G. Lof of Denver, Colo., whose home is solar heated, heat being stored in two huge cylinders filled with gravel through which solar-heated air passes. Also on this panel were R. N. Morse of the Commonwealth Engineering Division, Australia, and Maria Telkes of Curtiss-Wright. Dr. Telkes described the solar oven which her firm is developing, and which may compete with that symbol of outdoorsy living, the charcoal broiler. It also could be used as a heater, rotated gradually from east to west to capture the maximum solar energy.

Later sessions heard from F. E. Edlin of du Pont, David Jenkins of the Office of Saline Water, Department of the Interior, G. L. Pearson of Bell Telephone Laboratories, Irving Wolff of RCA Laboratories, P. E. Glaser of Arthur D. Little, Inc., Knox Millsaps who is Chief Scientist of Hollomon Missile Development Center, N. Mex., John Davies, Quartermaster Research and Development Center, Natick, Mass., and M. B. Prince of Hoffman Electronics.

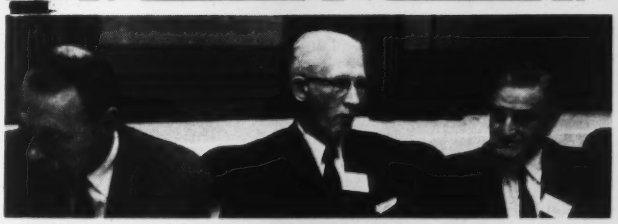
Jan Oostermeyer, president of the Association, was among those present at the banquet. Main speaker was Dr. Farrington Daniels of the University of Minnesota, who spoke of the task of bringing solar energy to the underindustrialized areas of the world. The problem has three facets, technical, economic, and sociological, the latter asking, "will people accept the new way of life?"

"There are 400 million people in India," he said, "and if 1 per cent accepted such devices, that four million would be a considerable market."

He stated that in the past four years, we have seen three break-throughs in solar energy progress. One is the fluorinated plastic materials which are thin and strong, and serve as covers for collectors. Another is the silicon photo cell which converts sunlight into electricity with an efficiency of 10 per cent. The third is the thermoelectric converter, or fuel cell.

He emphasized that solar energy appeared most highly suited for applications in the home.

"The capital investment for 'going entirely on the sun' is tremendous," he said, "but by 1975 we might actually have that 11 million such homes predicted by Truman's investigating committee in 1952."



Top: H. K. Work, NYU; Jan Oostermeyer, president of the Association; Harry Tabor from Israel

Center: W. B. Gibson, Stanford Research Inst.; Arthur Brandon, NYU; Farrington Daniels, U. of Wisconsin

Bottom: Dr. John Nielsen, NYU's Co-ordinator of Research for Engineering, Represented NYU as host to the conference

Prof. H. C. Hoyt of M.I.T.'s Chemical Engineering Department reports on "selective" black surfaces

Recipients of the first Engineers' Day Honor Awards presented by the Washington University School of Engineering, St. Louis, Mo., stand with University officials outside Graham Memorial Chapel on the campus, where the award ceremony was held on March 13. They are, **left to right**, G. V. Williamson, Fellow ASME; Webb Kammerer, member of the University board of directors; A. C. Weber, Laclede Steel Company, St. Louis, Mo.; Dean D. A. Fischer of the School of Engineering; and F. B. Langreck, Monsanto Chemical Company, St. Louis, Mo. All three recipients are alumni of the Washington University School of Engineering.

PEOPLE

Honors and Awards. WILLIAM F. RYAN, ASME past-president, has been named the recipient of the 1959 NSPE Award for outstanding service to the engineering profession. The award cited Mr. Ryan for his "outstanding contributions as a professional engineer in the field of mechanical design, for his unselfish devotion to professional principles and ideals, and, more importantly, his untiring efforts in the practical implementation of these concepts for the benefit of the profession and mankind."

LILLIAN M. GILBRETH, Hon. Mem. ASME, often described as the world's foremost woman engineer, received the Allan R. Cullimore Medal at the 43rd commencement exercises of Newark College of Engineering.

WILLIAM E. SHOUPP, Mem. ASME, has been named a fellow of the AIEE. He was cited for his "contributions to the technology of nuclear power generation and submarine propulsion."

A. O. SCHMIDT, Mem. ASME, and K. J. TRIGGER, Mem. ASME, were recipients of National Honor Awards of the American Society of Tool Engineers. Mr. Schmidt received the ASTE Medal for his contributions as "an authority in the areas of machinability and thermodynamics of metals." Professor Trigger was awarded the ASTE Research Medal for work as a "basic researcher in the fields of physical metallurgy, metal cutting, and machinability of metals."

CLARENCE ZENER, director of the Westinghouse Electric Corporation research laboratories in Pittsburgh, Pa., has been elected to membership in the National Academy of Sciences for "distinguished and continued achievements in original research."

AUGUSTUS B. KINZEL, vice-president-research, Union Carbide Corporation, received the Stevens Institute of Technology Powder Metallurgy Medal.

TAKASHI NAKADA, Tokyo Institute of Technology professor, is a Fulbright Professor working with Prof. Rufus Oldenburger, Mem. ASME, at Purdue in the School of Mechanical Engineering. Prof. Nakada has just received an award from the Japan Society of Mechanical Engineers for a paper on the numerical control of machine tools. Until now this society has not given any such awards. The occasion is the 60th anniversary of the society. Other awards have gone to one person in each of the major fields of mechanical engineering to mark the celebration.

New Appointments. LEWIS K. SILLCOX, past-president and Hon. Mem. ASME, has been named by GOVERNOR ROCKEFELLER as director of the newly created State Office of Transportation. Mr. Sillcox, retired first vice-president of the New York Air Brake Company, Watertown, N. Y., will be charged with developing an over-all transportation policy in co-operation with the Federal government and neighboring states, with special emphasis on the critical commuter problem. His appointment is subject to confirmation by the New York State Senate when it reconvenes in January, 1960.

JOHN O. AMSTUZ, Fellow ASME, has been named First Deputy Commissioner of Commerce for New York State. In commenting on the appointment, KEITH S. MCHUGH, Commissioner of the State Department of Commerce said, "Mr. Amstuz's broad background and experience as an engineer and manufacturing executive make him a valuable associate. . ."

EDUCATION

Technical Writing

AN OPPORTUNITY for scientists and engineers to gain practical instruction and supervised practice in the preparation of effective technical reports will be offered Sept. 13–25, 1959, by The Pennsylvania State University, University Park, Pa.

Program for the Technical Report Writing Seminar will consist of lectures and workshop periods. Lectures will include discussions of the characteristics of good technical writing and methods of achieving them; review of the mechanics of writing; discussions of the organization of a report and of each of its components; and the use of such graphic aids as photographs, tables, charts, and graphs.

Further information may be obtained from the Extension Conference Center, The Pennsylvania State University, University Park, Pa.

New Curriculums

The Pennsylvania State University. Effective next Fall, the Pennsylvania State University will offer a curriculum in engineering mechanics. The curriculum will lead to the BS degree.

Students enrolling in the new curriculum will have the choice of two options. The mechanics option will cover the more mathematical aspects of mechanics and will provide specialized training for stress and vibration analysts.

Columbia University. Columbia University's School of Engineering will open its doors to freshmen next Fall for the first time since 1914.

A small group of highly qualified graduates of secondary schools will begin the new undergraduate program leading to a bachelors' degree in engineering. Through the years the entering class is expected to grow to a maximum of 200.

Computer Research

A LABORATORY where basic research will be conducted in the field of computers and computing devices is being established in the new Engineering Laboratory Building at Washington University, St. Louis, Mo. Research work will be in full operation by the beginning of the fall semester.

This Computing Devices Research Laboratory will stress research in the areas of digital computers, mathematical matrix equation analyzers, network analyzers, and electronic control devices for computers.

INDUSTRIAL FILMS

Presses in Operation

"Hands of the Giants," a new 16-mm, 30-min, sound-color film depicts the forging of highly intricate aircraft components on one of the world's largest closed-die forge presses. Shot at the North Grafton plant of Wyman-Gordon Company, the film shows how metal is forced into predetermined complex shapes by the force of multistoried forge presses of 18,000, 35,000, and 50,000 tons.

The film is available without charge from Wyman-Gordon Company, Worcester 1, Mass., for showing to engineering schools and industrial groups.

Hydraulic Presses

"The Multi-Viewpoint," is a documentary on how tooling and production men are simplifying production operations with modern hydraulic multipresses. Press operations in a wide variety of industrial applications are shown, on both automatic and semiautomatic operations. The advantages of hydraulic presses to plant layout, high production, versatility, and cost reduction are analyzed. Running time of the new 16-mm film is 25 minutes.

A descriptive folder and order blank may be obtained from Denison Engineering Division, American Brake Shoe Co., 1160 Dublin Rd, Columbus 16, Ohio.

Uranium Feed Materials

"The Production of Uranium Feed Materials" tells the story of the processing of uranium ore concentrates into pure uranium. The film was produced for the Atomic Energy Commission Oak Ridge Operations by Continental Film Productions, Chattanooga, Tenn. Scenes for the 16-mm color film were shot at the Commission's large feed materials plants at Weldon Spring, Mo., and Fernald, Ohio. Prints of the film are available from the Commission's 11 film libraries.

Material Handling

"Industrial Material Handling Films" is the title of a new 16-page booklet which reviews films that are available from member-companies of The Material Handling Institute, Inc.

The catalog is available without cost from The Material Handling Institute, Inc., One Gateway Center, Pittsburgh 22, Pa. Briefly described in the catalog are 63 industrial material handling films. Complete ordering information is given. These films—sound and silent; black and white, and color—are available for loan at no cost other than normal shipping and insurance charges.

Film Catalog

"The science of Making Brass," "Steel in Concrete," and "Compressed Air Power," are some of the films listed in a new industrial-film catalog. The catalog is issued by Modern Talking Picture Service, Inc., 3 East 45th Street, New York 22, N. Y. The catalog lists 23 16-mm industrial films on a number of subjects of interest to engineers and students.

RESEARCH

Automotive Research

Exhaust-gas analysis with respect to smog-producing tendencies, air conditioning of rapidly moving vehicles, corrosion problems in automotive structures, stress and vibration during road operation, and carburetor and intake manifold studies aimed at fuel economy are some of the research projects that will receive particular attention from The University of Michigan's automotive research facilities in the College of Engineering.

These projects will be studied with the aid of the only known Mobile Automotive Laboratory in existence. Specially designed for on-the-road studies of every aspect of motor vehicle performance, the Lab was presented as a gift from the International Nickel Company to Michigan's College of Engineering.

While the Mobile Lab will be a major adjunct to the University's research facilities, it will also serve as a unique engineering educational tool that will go far in amalgamating the basic engineering theory of the classroom with the actual problems of industry. The Lab was conceived by Prof. William H. Graves, head of Michigan's Automotive Engineering Laboratory. There is space and instrumentation aboard to accommodate up to 18 persons.

"Operation Button Jar"

"Operation Button Jar," a unique idea to obtain needed equipment for scientific laboratories in universities, has been launched in Cleveland. Originally developed by Reese and Miller, Inc., a Cleveland firm that specializes in the preparation of technical literature, the start of the project is being conducted in conjunction with Case Institute of Technology.

The main purpose of "Operation Button Jar" is to gather discarded material and equipment from industry, reclassify it, and distribute it to colleges that can put it to good use in their laboratories. Such odds and ends are needed in the laboratory, but often are not provided for in ordinary academic budgets. At the same time, industry scraps tons upon tons of such items each year.

The project received its name from the old fashion household button jar; once a vital "tool" of the housewife.

The range of odds and ends needed by "Operation Button Jar" is quite broad. It covers everything from nuts and bolts to relays and vacuum tubes. Material will be distributed to all types of academic laboratories—mechanical, electrical, chemical, physical, hydraulic, and electronic.

Dr. E. C. Anderson, Los Alamos Scientific Laboratory scientist, with samples of dried milk used in study of radioactivity from fallout in milk and in human beings. Los Alamos' program studies radioactive fallout and its potential dangers by making weekly measurements of a radioactive fission product, cesium-137, in people and in the milk supply.

ASME Still Short of UEC Goal

Region V Does It Again... Ben King, left, receives from Vice-President E. W. Allardt, Certificate of Award for West Virginia Section's successful Building Campaign. Section's record shows 126 per cent of quota, with 80 per cent of members giving.

...And Again. Region V continues to forge ahead in the Member Gifts Campaign for UEC as Earl Cutter, left, Campaign Chairman, receives Certificate of Award from Jesse Wilder, right, Dayton Section Chairman. R. J. Flanigan, center, vice-chairman of Section, smiles approval.

ALTHOUGH ASME and a number of other societies continue to lag (see table) in the Member Gifts Campaign, representatives of the United Engineering Trustees and the Turner Construction Company signed a contract, May 28, 1959, for erection of the $10 million, 18-story, United Engineering Center in Manhattan. The contract signing took place at the Engineers' Club, 32 West 40th Street, New York City.

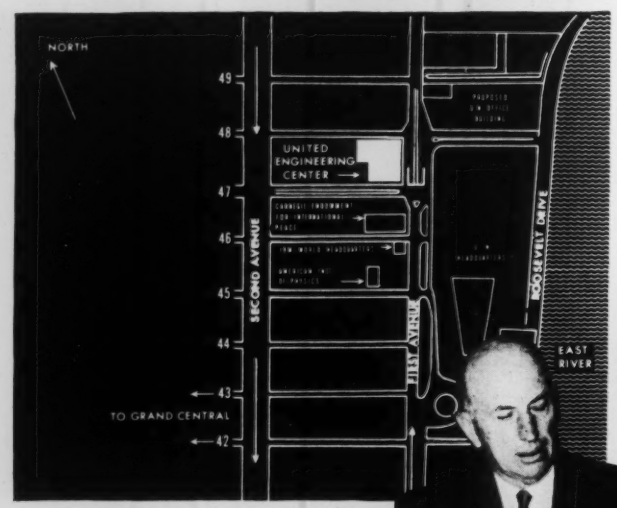
The Center, to be located between 47th and 48th Streets on United Nations Plaza (First Avenue) opposite the United Nations, will house many of the nation's major professional engineering groups, superseding the 50-year-old Engineering Societies Building on 39th Street.

Ground-breaking for the new structure is scheduled for this fall. According to UET the structure will be ready for occupancy in 1961.

UEC Building Fund — Member Gifts Campaign Status

(As reported on June 5)

	Quota	Subscriptions	Number of Subscribers	Per Cent of Quota
ASCE	$800,000	$510,860.23	8,429	63.8
AIME	500,000	281,968.44	4,092	56.4
ASME	800,000	529,347.20	10,716	66.0
AIEE	900,000	755,356.85	20,158	84.0
AIChE	300,000	298,129.31	7,179	99.4
AICE	80,000	20,818.33	42	26.0
AIIndE	70,000	30,900.00	963	43.2
SWE	7,000	2,162.00	7	30.9
AWS	60,000	6,814.17	57	11.3
ASHRAE	.....	541.00	23	.....
Other	.....	7,097.41	197	.....
Total		2,443,994.94	51.863	



The Contract Is Signed. At the Engineers' Club, New York City, on May 28, 1959, United Engineering Trustees and Turner Construction Company signed a contract for the erection of the United Engineering Center. Signers shown, seated left to right, are: Willis F. Thompson, Fellow ASME, chairman, UET Real Estate Committee; Andrew Fletcher, UET president; and E. K. Abberley, vice-president of Turner Construction Company. Standing are: Harold C. Bernhard, partner, Shreve, Lamb & Harmon Associates, architects; and W. B. Ball, vice-president and secretary, Turner Construction.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

1959 ASME West Coast Applied Mechanics Conference to Be Held in Stanford

THE 1959 West Coast Conference of Applied Mechanics will be held Sept. 9–11, 1959, at Stanford University Physics Lecture Hall, Stanford, Calif.

The conference is sponsored by the Applied Mechanics Division of The American Society of Mechanical Engineers in conjunction with the American Society of Civil Engineers.

▶WEDNESDAY, SEPTEMBER 9

Registration 8:15 a.m.

General Lecture 9:00 a.m.

Principal Modes of Vibration in Nonlinear Systems of More Than One Degree of Freedom, by *R. M. Rosenberg*, Univ. of California, Berkeley

Session 1 10:00 a.m.

Transfer Matrix Fundamentals, by *E. Pestel*, Technical Univ., Hannover, Germany, and *F. A. Leckie*, Univ. of Cambridge, England

Vibration Modes Analysis of Low Aspect Ratio Aircraft Structures, by *H. W. Bergmann*, Convair, Fort Worth, Texas, and *E. Pestel*, Technical Univ., Hannover, Germany

Transfer Matrixes Applied to Plate Theory, by *F. A. Leckie*, Univ. of Cambridge, England, and *E. Pestel*, Technical Univ., Hannover, Germany

Session 2A 2:00 p.m.

The Use of Nonsinusoidal Approximating Functions for Nonlinear Oscillation Problems, by *K. Klotter*, Stanford Univ., and *P. R. Cobb*, Arizona State Univ.

On Certain Classes of Self-Sustained Oscillation, *K. Klotter*, Stanford Univ.

Response of a Nonlinear String to Random Loading, by *T. K. Caughey*. California Inst. of Tech. (Paper No. 59—APMW-4)

Response of Van Der Pol's Oscillator to Random Excitation, by *T. K. Caughey*, California Inst. of Tech. (Paper No. 59—AMPW-5)

Session 2B 2:00 p.m.

Bending of Isosceles Right Triangular Plates, by *H. J. Fletcher*, Brigham Young Univ. (Paper No. 59—APMW-19)

Bending of Plates on a Viscoelastic Foundation, by *K. S. Pister*, Univ. of California, Berkeley, and *M. L. Williams*, California Inst. of Tech.

Calculation of Thermal Stress Distribution in Perforated Plates, by *L. I. Deverall*, Univ. of California Radiation Lab.

Transverse Flexture of a Semi-Infinite Thin Plate Containing an Infinite Row of Circular Holes, by *O. Tamate*, Tohoku Univ., Sendai, Japan (Paper No. 59—APMW-15)

Stresses in a Circular Cylinder Having an Infinite Row of Spherical Cavities Under Tension, by *A. Atsumi*, Tohoku Univ., Sendai, Japan (Paper No. 59—APMW-9)

▶THURSDAY, SEPTEMBER 10

Registration 8:30 a.m.

General Lecture 9:00 a.m.

On Stress Functions in Dynamic Elasticity, *E. Sternberg*, Brown Univ.

Session 3 10:00 a.m.

Forced Oscillations of an Elastic Half-Space, by *M. P. Stallybrass*, Stanford Research Inst.

Axially Symmetric Waves in Elastic Rods, by *R. D. Mindlin*, Columbia Univ., and *H. D. McNiven* (Paper No. 59—APMW-2)

Vibrations and Waves in Elastic Bars of Rectangular Cross-Section, by *R. D. Mindlin*, Columbia Univ., and *E. A. Fox* (Paper No. 59—APMW-23)

A Method for Solving Linear Partial Differential Equations, by *Stefan Bergman*, Stanford Univ.

On the Propagation of Shock-Waves in a Non-Homogeneous Elastic Medium, by *E. Sternberg*, Brown Univ., and *J. G. Chakravorty* (Paper No. 59—APMW-17)

Session 4A 2:00 p.m.

Viscous Damping in Flexural Vibrations of Bars, by *N. K. Newman*, Univ. of Notre Dame (Paper No. 59—APMW-8)

Flexural Vibrations of Sandwich Plates, by *Y. Y. Yu*, Polytechnic Inst. of Brooklyn

Free Vibrations of Skin-Stringer Panels, by *Y. K. Lin*, Boeing Airplane Co.

Developments in the Application of the Grid Method to Dynamic Problems, by *A. J. Durelli, J. W. Dally*, and *W. F. Riley* (Paper No. 59—APMW-1)

The Free Vibrations of Grillages, by *J. P. Ellington*, United Kingdom Atomic Energy Authority and *H. McCallion* (Paper No. 59—APMW-12)

The Fundamental Frequency of a Thin, Flat, Circular Plate Simply Supported Along a Circle of Arbitrary Radius, by *R. Y. Bodine*, Univ. of Wisconsin (Paper No. 59—APMW-10)

Session 4B 2:00 p.m.

Rupture Characteristics of Safety Diaphragms, by *N. A. Weil* (Paper No. 59—APMW-3)

The Melting of Finite Slabs, by *T. R. Goodman*, Allied Res. Associates, Inc., and *J. J. Shea* (Paper No. 59—APMW-11)

Slow Rotary Motion of a Circular Disk About One of Its Diameters in a Viscous Fluid, by *R. P. Kanwal*, Univ. of Wisconsin (Paper No. 59—APMW-6)

Effect of the Wall on Two-Phase Turbulent Motion, by *S. L. Soo*, Princeton Univ., and *C. L. Tien* (Paper No. 59—APMW-18)

Boundary-Layer Solution for a Flow in A Diverging Passage Having a Swirl Component, *M. A. Sinbel*, General Petroleum Authority, Egypt (Paper No. 59—APMW-14)

Heat Transfer for Laminar Flow in Ducts With Arbitrary Time Variations in Wall Temperature, by *R. Siegel* (Paper No. 59—APMW-21)

▶FRIDAY, SEPTEMBER 11

Registration 8:30 a.m.

General Lecture 9:00 a.m.

Plastic Analysis of Plates and Shells, by *P. G. Hodge, Jr.*, Illinois Inst. of Tech.

Session 5 10:00 a.m.

Plastic Stress Concentration of a Circular Hole in an Infinite Sheet Subjected to Equal Biaxial Tension, by *B. Budiansky*, Harvard Univ. (To be presented by *O. L. Mangasarian*) (Paper No. 59—APMW-16)

Resolution of Plastic Strains With Components of Symmetrically Isotropic Behavior, by *G. A. Zizicas*, Univ. of California, Los Angeles.

Large Deflection of Elastoplastic Plates Under Uniform Pressure, by *T. Wah*, Southwest Res. Inst.

On the Effect of Shear on Plastic Deformation of Beams Under Transverse Impact Loading, by *B. Karunes*, Brown Univ., and *E. T. Onat* (Paper No. 59—APMW-7)

Session 6 2:00 p.m.

Limit Analysis of Simply Supported Circular Shell Roofs, by *M. N. Fialkow*, U. S. Army Engineer District, New York, N. Y.

On the Asymmetrical Bending of Conical Shells, by *B. Wilson*, Univ. of Kansas

Difference Coefficients of Shallow Spherical Shells, by *H. E. Williams*, Jet Propulsion Lab.

The Solution of Elastic Stability Problems With the Electric Analog Computer, by *J. H. Shields*, Computer Engineering Associates, Inc., and *R. H. MacNeal* (Paper No. 59—APMW-20)

On Stress-Strain Relations and Strain-Energy Expressions in the Theory of Thin Elastic Shells, by *J. K. Knowles*, California Inst. of Tech., and *E. Reissner* (Paper No. 59—APMW-13)

Postbuckling Behavior of Rectangular Plates With Small Initial Curvature Loaded in Edge Compression-Continued, by *N. Yamaki*, Tokohu Univ., Sendai, Japan (Paper No. 59—APMW-22)

Registration

Wednesday, September 9	8:30 a.m.–4:00 p.m.
Thursday, September 10	8:30 a.m.–4:00 p.m.
Friday, September 11	8:30 a.m.–3:00 p.m.

Registration and all sessions will be held in the new Physics Lecture Hall, Lomita Drive (West of Quadrangle).

Modern Design goes to Design Engineering Show. Each visitor, after registering, receives small, embossed card with his name, title, company, and address. As he makes his way among the exhibits and finds something he wants to study at leisure, he hands the card to the exhibitor with his request for literature, samples, and so on. Just as easy as "Charge it" is in a department store.

1959 ASME DESIGN ENGINEERING CONFERENCE

Technical and general sessions designed to disseminate information that can be used now to design for the future . . . covered trends, developments, and data for components, mechanical parts, and materials. Famous design engineer describes German economic conditions, technical education, and role of engineering executives. Psychology and engineering do mix—a psychologist proves it. Add all this to the biggest Design Engineering Show and it becomes easy to see why in the past four years this combination has become the great event on the engineering calendar.

MANY "Made in U. S. A." products can no longer be sold in the free world market against European and Japanese competition, according to Hellmuth Walter, Mem. ASME, director of research of the Worthington Corporation.

Mr. Walter, speaking at the opening session of the Design Engineering Conference in Philadelphia, Pa., May 25, said, "We are pricing ourselves out of this world."

The Design Engineering Conference, May 25–28, was sponsored by the Machine Design Division of The American Society of Mechanical Engineers. This year for the fourth time it was held concurrently with the Design Engineering Show which is produced by Clapp & Poliak of New York City. Close to 1400 engineers attended the conference and more than 18,000 engineers, scientists, and their "customers" saw the show—these figures eloquently assess the importance of this joint annual venture.

The Price Is the Thing

That the price is the real reason we are losing our export market is borne out by the fact that the same American designed product when produced abroad by subsidiaries usually is highly competitive and the subsidiary companies are prosperous and profitable.

"The sales of U. S. Foreign subsidiaries are estimated to amount to two or three times that of the total U. S. export sales," he said.

"The American product," Mr. Walter added, "has been designed largely for mass and volume production. This results in an amazingly inexpensive product for the U. S. home market . . . but it makes radical model changes and improvements of the product costly for the manufacturer. This fact can be costly to our economy as a whole!"

He cited the invasion of the small foreign car as an example and pointed out that the economy of every other country continually faces similar problems. However, they are more flexible in handling them due to lower engineering and tooling costs.

German economy arising from a desperate situation is accumulating gold and dollar reserves with exports growing. "They were fortunate in having great educators at government level who taught them to earn more than they spent," said Mr. Walter. Initially, this growth was made possible by (1) Currency reform; (2) American aid; and (3) the determination of the German people to work long and hard.

The dismantling of German industry right after the war, he noted, was a "blessing in disguise" as was the influx of ten

million German refugees from Soviet-dominated countries. Wages, in ten years, have increased 90 per cent while the cost of living advanced only 20 per cent; thus the industrial worker now can buy 60 per cent more than in 1949. The work day has been reduced; little time has been lost due to strikes.

"The trade unions," he said, "show a remarkable restraint because nothing is more dreaded and unpopular in present-day Germany than inflation."

A New German Army

Due to the technical educational curriculums, and this has been true in Germany for decades, there is a well-organized army of trained manpower consisting of soldiers, noncommissioned, and commissioned officers. The soldiers are the vast number of trained mechanics, electricians, machinists, molders, coppersmiths,carpenters, and so on, all of whom had to pass a final test after three years of apprenticeship.

The noncommissioned officers and officers with medium shop and school training—technicians, draftsmen—and the officers with full academic training are the army. The echelons—top to bottom—have had practical experience in industry.

Mr. Walter said that the organizational form of German management may be defined as "autocratic," . . . "autocratic with back talk," allowing the individual some elbow room. He added, "autocratic rule leads more easily to grave mistakes because it depends on single persons for decision making. The democratic form of group [committee] management is slow and leads often to complicated designs because it relies on component specialists."

With the coming of mass production, he pointed out, the amount of design-engineering work is negligible. A few decades ago ten times as many companies were building automobiles. All in search of the ultimate product—have accomplished what borders on a miracle. Functionally and in performance they are all practically alike to be distinguished only by decoration and manner in which they are advertised.

In conclusion, Mr. Walter cited the Volkswagen as the typical example: Conceived by one man, not a committee, the late Professor Porsche, his testament being executed by Dr. Heinz Nordhoff, the 1958 Sperry Award winner, the Volkswagen is a product that seems to contradict the typical American car in every way except that it also runs on wheels. It is small, economical, it does not change its appearance [annually], every part of it is functionally justified, and it is hardly advertised.

"Yet it is a highly successful design," he said, "and sold all over the world. Are we learning from it? Could not the American car manufacturers in a combined effort, if necessary, do likewise and produce a similar product suitable for export? The world demand is enormous. But it would probably require a genius like Henry Ford I, or like the Porsche-Nordhoff pair to accomplish this."

A Major Advance

The technical program designed to disseminate technical information that can be used now to design for the future reported a major advance in the design of heat-resisting materials.

I. J. Gruntfest, chemistry specialist of the missile and space vehicle department, General Electric Company, Philadelphia, Pa., described the development of new organic plastics which can resist transient temperatures of up to 15,000 F.

The new material, essential for missile nose cones and rocket motors, is taking the spotlight from refractory metals and ceramics, Dr. Gruntfest declared. The latter materials melt before they reach 5000 F.

"The extreme temperatures up to 15,000 F are encountered by nose cones of missiles, or satellite vehicles, during their re-entry into the atmosphere," Dr. Gruntfest pointed out. He also said, "Organic plastics melt when exposed to 500 F for long periods, but recent experiments have shown that for short periods of extremely high heat the organic plastics are most durable."

The conference papers covered trends, developments, and data for power and control components, mechanical parts, and materials that should aid the designer in his future work.

Psychology and Engineering Do Mix

Also considered was man in relation to the organization. Said Martin M. Bruce, vice-president and director, Psychological Services, Clark Channell, Inc.: "Human behavior is essentially emotional not logical, and an organization must take this into account." For engineering and research setups, a decentralized organization—such as GM or GE—is normally used since engineers and scientists work best in a democratic atmosphere.

"Regardless of the organization," Dr. Bruce continued, "a businessman runs the company and makes the decisions." But, as any business is made up of people, their handling is a major factor in productivity. Industrial psychologists give the company president a practical view which might otherwise be lost. "In other words," he said, "The social scientist is consulted to broaden perspective for understanding."

All organizational structures are based on trial and error; there is no general organization program that can be applied. The psychologist uses research to approach an answer, but must evaluate each form of structure. "Normally,"

Dr. Bruce observed, "the company suggests the approach; psychologists give the advantages and limitations; and the president selects the final structure."

A list of the Conference technical papers—authors, titles, and ASME numbers—appears in this issue, p. 104. In addition, all papers which are not scheduled for publication in MECHANICAL ENGINEERING will be abstracted in "ASME Technical Digest."

The Design Engineering Show

Descriptions running the gamut from "dream-world hardware store" to "a long, realistic look into the atomic/space age" are adequate, but the Design Engineering Show is this and considerably more.

The $10 million show of equipment, components, and materials—some so new that applications are "unknown"—presented concurrently with the ASME Design Engineering Conference, was viewed by some 18,000 design engineers and men who buy and sell the 12,000 products displayed and demonstrated by 401 exhibiting companies.

The show, now rated one of the three largest annual industrial expositions in the country, is produced by Clapp & Poliak, Inc., of New York City. This year, as for the first in 1956, the Design Engineering Show was held at Convention Hall and 125,000 sq ft of exhibit space was utilized. The second show, held in 1957, was in New York City and, in 1958, Chicago, Ill.

A boon to the viewer—introduced last year—was again a great assist. After registering, visitors were asked to stop and get their names, titles, companies, and addresses embossed on a card—similar to a charge plate. This simple little card was the viewers' welcome helper. As he made his way among the exhibits and found something he wanted to study at his leisure, he handed his card to the exhibitor with a request for literature, samples, or to set up an appointment to "do business."

When he had seen all he wanted to see, he was not loaded down with wanted and unwanted material, and the persons to whom he had spoken had his name properly spelled and request clearly understood; thus good communication had been painlessly designed into the show.

For those of us who have difficulty keeping an ordinary watch running and properly set, the most fascinating item at the show was a clock built by Ralph B. Mentzer, assistant director of the process development laboratory of the Hamilton Watch Company, after a design by I. M. Levitt, Fels Planetarium, The Franklin Institute. The clock tells Martian time . . . it also tells Greenwich civil time, but that seems so prosaic now that we are in orbit. The experimental clock is really a computing mechanism and can be used for demonstration purposes; e.g., a full 24-hr earth day can be observed in 45 sec.

A feature attraction of the show was a small unobtrusive device in a glass enclosed box. The object produces heat and cold with a moving part, without noise, vapor, or without obvious explanation.

Among the products on exhibition, many of them wonders of technical perfection, was a device, a phenomenon of thermoelectric principles, that evolves electricity by heat.

Also featured at the show was the first public showing of vinyl-coated steel. The plastic coating will permit household appliances and metal furniture to achieve soft leather, fabric, or wood finishes and therefore will require practically the minimum of maintenance.

Kaiser Aluminum & Chemical Corp. showed the designers an all-aluminum automobile which, the company says, is "ready for the immediate future."

Many companies displayed products for which they see no immediate application. The engineers were asked to consider the items for inclusion in design ideas.

Attracting wide interest among designers is a "do-it-yourself" kit which resembles a mechanical toy, which contains gears, shafts, drive belts, and similar components to permit the designer to assemble a prototype of a working machine and thus eliminate expensive drawings and models. It is being introduced by Overseas Commodex, Inc., Detroit.

In the Canadian Government's exhibit is a new type of ventilator which brings in fresh air and exhausts stale air on a single shaft. Also being shown there is the "first geophysical instrument ever developed in portable form for detecting beryllium," a vital metal in the atomic series.

General Electric Corp. is introducing a fractional hp motor assembled by a radically new method to insure accuracy of alignment. The motor is said to increase efficiency by 40 per cent. No screws, rivets, or other mechanical fasteners are used in its assembly.

Of major interest in the tracking of missiles is a development which may ultimately lead to the use of rockets for cargo delivery, according to the Ballistic Research Laboratories, U. S. Army Ordnance, Aberdeen Proving Grounds, Md. The device, called an electronic angle encoder, is capable of measuring an angle of a missile's flight within 90 ft of accuracy at 1000 miles.

Availability List—Design Engineering Conference

THE papers in this list are available in separate copy form until March 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

59—MD-1 Developments in Plastics for High-Temperature Service (Above 1000 F), by Irving Gruntfest

59—MD-2 New Developments in Metals and Ceramics for High-Temperature Service (Above 1000 F), by J. J. Harwood

59—MD-3 Variable Speed D-C Drive Systems, by M. H. Sluis

59—MD-4 Semi-Conductor Power-Conversion Equipment, by J. J. Rheinhold

59—MD-5 The Design and Application of Belts, Chains, and Gears, by E. S. Cheaney, C. L. Paullus, and W. C. Raridan

59—MD-6 Clutch, Fluid Coupling, Hydraulic Torque Converter . . . Appication Considerations and Performance Comparisons, by R. W. Bachmann

59—MD-7 Latest Developments in Materials to Resist Chemical Corrosion, by S. W. Shepard

59—MD-8 Recent Developments in Materials and Finishes to Resist Atmospheric Corrosion, by E. B. Friedl, L. J. Nowacki, and W. H. Safranek

59—MC-9 Digital Systems in Control Applications, by I. L. Auerbach

59—MD-10 Logic Circuits for Machine Control, by E. V. Weir

59—MD-11 Design Curves for Journal Bearings, by D. F. Hays

59—MD-12 Which Bearing and Why?, by A. O. DeHart

59—MD-13 A Graphic Method for Engineering Organization Analysis, by E. M. Ramberg and R. P. Dominic

59—MD-14 The Man and the Organization, by M. M. Bruce

Seventh Annual National Engineering Management Conference

THE Seventh Annual National Engineering Management Conference will take place at the Statler Hilton in Los Angeles, Calif., September 17–18. The conference is jointly sponsored by The American Society of Mechanical Engineers and the American Institute of Electrical Engineers with the co-operation of AIChE, ASCE, AIIE, the Metallurgical Society of AIME, and the Los Angeles Section of the Institute of Radio Engineers.

The Honorable George D. Clyde, Governor of the State of Utah, will deliver the Keynore Address for the conference. The theme is Managing Engineering Resources. Other outstanding personages from industry, education, and government will make presentations on such vital subjects as developing engineering managers, concepts of engineering controls, and engineering programs for new frontiers.

A full program also is being planned to include tours and visits to many outstanding points of interest for the women.

The technical program follows:

▶ THURSDAY, SEPTEMBER 17

Session 1—Development of Engineering Managers — **9:30 a.m.**

Philosophy of Engineering Managers, by *J. L. Young,* U. S. Steel Corp., Pittsburgh, Pa.

Developing Managerial Abilities, by *F. F. Bradshaw,* Richardson, Henry & Bellows, New York, N. Y.

Session 2—Development of Engineering Managers—Case Histories — **2:30 p.m.**

Development of Engineering Managers of Small Companies, by *Philip Fogg,* Consolidated Electrodynamics

Development of Engineering Managers in a Governmental Organization, by *Byron Grant,* Los Angeles Department of Water and Power

▶ FRIDAY, SEPTEMBER 18

Session 3—New Concepts of Engineering Controls — **9:30 a.m.**

Control of the Engineering Function, by *Harry Good,* University of Michigan, Ann Arbor, Mich., and Bendix Aviation Corp.

Development of Integrated Engineering Controls, by *J. S. Sayer,* E. I. du Pont de Nemours & Co., Inc.

Development of Integrated Engineering Controls—Case History, by *Norman Ream,* Lockheed Aircraft Corp.

Session 4—Engineering Planning — **2:30 p.m.**

Decision Making in Engineering (speaker to be announced)

Engineering Programs for New Frontiers (Proposed) (Speaker to be announced)

1959 Wood Industries Conference to Be Held in Portland

THE Multnomah Hotel in Portland, Ore., will be the site of the Wood Industries Conference sponsored by The American Society of Mechanical Engineers, the American Institute of Chemical Engineers, and The Forest Products Research Society with the co-operation of the ASME Oregon Section. The dates are September 10–12.

Subjects to be covered during the highly diversified conference planned for the benefit of operating, technical, and management personnel engaged in all phases of the wood industry include: new methods and equipment, management problems, materials handling, chemistry in wood utilization, and the commercialization of research results.

An outstanding feature of the conference will be a meeting summation which will be held in the new Forest Products Pavilion at the site of the Oregon Centennial Exposition. During this period a prominent member from each participating society (FPRS, ASME, and AIChE) will provide his analyses, impressions, criticisms, and so on, of the papers and information presented.

Several field trips are planned including visits to Timber Structures, Inc.; Nicolai Door Company; Stebco, Inc.; Weyerhaeuser Timber Company; International Paper Company; and The Longview Fibre Company.

▶ THURSDAY, SEPTEMBER 10

Session 1—Foundations for Profitable Research — **8:30 a.m.**

The Team, by *John Aram,* Weyerhaeuser Timber Co., Tacoma, Wash.

Research Risks, by *W. D. McGuigan,* Stanford Research Inst., Menlo Park, Calif.

Basic or Applied Research, by *Howard Barlow,* Washington Inst. of Tech., Washington State College, Pullman, Wash.

Growth and Development, by *Joseph Harrington, Jr.,* Arthur D. Little, Inc., Cambridge, Mass.

Session 2—New Methods and Equipment — **8:30 a.m.**

A Unique Method of Proportioning Wax and Resin in Particle Board Manufacture, by *John Balint,* Controls & Communications Co., Eugene, Ore.

The Effect of Variables on the Efficiency of Different Types of Mechanical Loading, by *J. A. McIntosh,* Canadian Forest Products Labs., Univ. of British Columbia, Vancouver, B. C., Canada

Edge and End Gluing of Lumber, by *J. H. Syme,* Engineering & Development Div., Edward Hines Lumber Co., Hood River, Ore.

The Development of Continuous Pulping Systems, by *J. O. McCutcheon,* Argus Engineering & Development, Ltd., Vancouver, B. C., Canada

Session 3—Management Problems — **1:30 p.m.**

Serendipity and Invention, by *F. E. Smith,* Smith & Tuck, Patent Attorneys, Seattle, Wash.

Forestry Under Pressure, by *M. P. Lazara,* Greenacres, Inc., Seattle, Wash.

Session 4—Materials Handling — **1:30 p.m.**

The Value of Inflated Dunnage for Shipping, by *R. C. Schrouder* and *P. H. Edblom,* Research & Development Dept., United States Plywood Corp., Eugene, Ore.

Automate Your Lumber Sorting, by *E. W. DeKoning,* Irvington Machine Works, Inc., Portland, Ore.

Truck Transportation of Wood Chips, by *H. E. Lovejoy,* Puget Sound Freight Lines, Seattle, Wash.

The Use of Suction Cups for Handling Wood Products, by *E. R. Schick,* The Union Tool Corp., Warsaw, Ind.

▶ FRIDAY, SEPTEMBER 11

Session 5—Chemistry in Wood Utilization — **8:30 a.m.**

Magnefite Pulping of Douglas Fir, by *R. M. Samuels,* Oregon Forest Products Research Center, Corvallis, Ore.

Organic Chemical Products From Wood, by *L. E. Van Blaricum,* Rayonier Inc., Olympic Research Div., Shelton, Wash.

Some Properties of the Cedar Phenols, by *R. H. J. Creighton,* Research Div., MacMillan & Bloedel Ltd., Nanaimo, B. C., Canada

Sawdust, Bark, and Other Wood Wastes for Soil Conditioning and Mulching, by *W. B. Bollen,* Oregon Agricultural Experiment Station, and *D. W. Glennie,* Oregon Forest Products Research Center, Corvallis, Ore.

Session 6—The Commercialization of Research Results — **8:30 a.m.**

Commercializing Research Results, by *E. M. Williston,* Wood Products Development Dept., Weyerhaeuser Timber Co., Longview, Wash.

Proving New Laminated Wood Building Products, by *R. J. Hoyle, Jr.,* Potlatch Forests, Inc., Lewiston, Idaho

▶ SATURDAY, SEPTEMBER 12

Session 7—General Interest and Meeting Summation — **9:00 a.m.**

This session will be held in the new Forest Products Pavilion at the site of the Oregon Centennial Exposition. The building features a sweeping seven-section hyperbolic paraboloid wood roof and will house many exhibits of the forest products of Oregon.

Utilization of Manpower, by *L. B. Hoelscher,* Weyerhaeuser Timber Co., Tacoma, Wash.

Wood Constructed Hyperbolic Paraboloids, by *J. G. Pierson* and *J. W. Storrs,* Portland, Ore.

Joint ASME-FPRS-AIChE Wood Industries Conference meets at Multnomah Hotel, Sept. 10–12, 1959, Portland, Ore. Planning committee, shown, **left to right,** A. Bruce Conlin, manager, Meetings and Divisions, ASME; H. A. McKeever, Mem. ASME; F. J. McCanna, Assoc. Mem. ASME; and Walter Ring, Long-Bell Division, International Paper Company.

ASME Production Engineering Conference . . .

. . . Looks at "Engineering—Products, Processes, and Planning—for Productivity"

Reading from the top. At the Production Engineering Conference, May 12–14, at the Statler Hilton Hotel, Detroit, Mich., Robert M. Critchfield, v-p, GM Process Development Staff, and major banquet speaker, tells of the challenges to be met in manufacturing. L. R. Cook, assistant v-p, Engineering Division, Western Electric, principal Organization Luncheon speaker, delivers talk on untapped sources of productivity. Raymond F. Hanson, GM Manufacturing Staff, presides at banquet. A. C. Pasini, assistant general superintendent, Production, Detroit Edison Company, presides at luncheon.

THERE's a word in your future! The word, part of your past and part of your present, is productivity. Crystal-ball gazing won't put it there, but efficient engineering effort, the kind that made American know-how synonomous with productivity, will.

Production engineers met at the ASME National Production Engineering Conference to look not into a crystal ball but at their products; their plants, processes, and equipment; their organization and management; and at themselves. They sought ways and means of meeting the challenge to the nation's productivity—the challenge of an increasing population, a proportionate decrease in the labor force, and thriving competition in world markets.

The city which gave a street address to productivity—Detroit—was the scene of the conference sponsored by the ASME Production Engineering Division in co-operation with the ASME Detroit Section. Headquarters was the Statler Hilton Hotel; the time, May 12–14, 1959.

Top engineers and representatives of the country's leading manufacturers were on hand to answer the question: "How to increase productivity?" Also available were answers from social scientists to the question: "Why increase productivity?"

The superior quality of the responses was such that one wished the group in attendance had been larger. The relatively low registration—about 125—did permit ample, lively discussion, and good fellowship.

Produce Products

All other considerations accounted for, the end result of productivity should be profit. Those whose efforts make up the final product profit from its sale. The consumer by possession of the product profits from its use.

Perhaps then, the conference, theme of which was "Engineering for Productivity," might better be titled "Engineering for Profit." How best to engineer an organization. . .a product. . .a process. . .so that it may be most productive and, hence, most profitable?

The most successful company uses all of its resources at optimum efficiency to "get all things right the first time." A concept of total quality control in combination with total cost control was offered as an aid to "getting things right the first time." Such a system integrates all elements in production: Marketing, engineering, purchasing, manufacturing engineering, manufacturing supervision and shop operation, mechanical inspection, shipping, right on up to proper installation. An approach of this type leads to greater productivity and fewer failures since all areas are keyed to the quality-control activity.

With a Product. A number of tools are available to the engineer designing a product for optimum efficiency. Two in particular were noted: First, operations research; second, the computer.

Operations research in product design forces consideration and definition of what is to be accomplished. OR seeks to learn: The needs of the market, how a product should be priced, how it fits into a company's manufacturing scheme, how it will affect inventory levels, how much money can be spent toward development, and the like. For the proper use of OR in design tasks, sufficient historical data must be available for the assessment of the level and trends of product requirements. It is essential also that design knowledge be amenable to numerical application.

Operations research can also be a tool in assessing in-process inventories. It can help in determining ordering times for raw materials, parts, subassemblies, and all items that go into a final product at different points in a process. An OR approach will enable manufacturers to maintain sufficient inventories to permit free-flowing production without expensive delays and without unnecessarily high investment.

In product design, computer merit lies in its ability to relieve the engineer of his noncreative functions and multiply his ability to do mental work. The computer allows the engineer to examine many alternate designs of his product, the design is produced faster, and, if

redesign is necessary, it is simplified substantially.

The product, once designed, its reliability also can be measured. Necessary steps to a reliability-measurement program include a formal data-feedback system, and an organization to digest data and initiate corrective action either on emergency information or repetitive items. Reporting documents and the mechanics of such a system were described.

Given a product, one that is reliable, how to set up a process? With the increasing size and complexity of automatic manufacturing facilities, there is a need for a tool which will provide a more complete and more realistic analysis of such facilities while they are still in the planning stage. Simulation is a tool which can provide this complete analysis.

Many simulation studies employ computers and higher mathematics. That these are not prerequisites for simulation work, however, was emphasized strongly. A simulation study usually will follow six steps: Define the problem, measure factors, relate factors, find significant factors, develop model, test and modify model. Models may be simple pencil and paper sketches or complicated computer programs. The important fact in simulation is the creative imagination of the engineer.

With Processes and Equipment. Engineering creativity is continually providing new processes and equipment at a pace with development or discovery of new properties of materials.

Among the processes which are permitting greater productivity are electric discharge machining (EDM), chipless forming of toothed parts by rolling, and shear spinning (a method for shaping metals by plastic deformation). Each of these processes and its companion equipment were described in some detail.

Metal processing received considerable attention in the form of the first literature review of the field for 1958. Metal cutting analysis, plastic working, and grinding were covered.

Introduction of numerical control techniques is another area which speaks well for increased productivity. Numerically controlled machine tools have been developed and have been in practical use, particularly among airframe manufacturers. Economic benefits from their use have been measured and, over a large range of parts, show substantial reductions in machining time and corresponding labor costs. Additional benefits accrue from reduced scrap and reduced elapsed time.

With Planning at the Top. Who is responsible for continual improvement in productivity? Obviously, it starts with planning among top management, but no one function has all the responsibility. For example, engineering, sales, and manufacturing all play a part in this continual improvement. One firm's organization for continual productivity gains in its manufacturing operations was described. The system, through careful planning, has shown that continuous improvements in productivity can be obtained.

Planning a new plant and the attendant problems which confront management were also described in detail. The plant in question was a replacement for 15 widely scattered plants with about 4000 employees. Problems involving basic planning, cost of facilities, new organizational relationships, and new principles of production control were noted.

A particular problem, the job shop, was considered from the viewpoint of organization of central stores and dispatch systems for productivity. Such productivity need not stem solely from reductions in direct labor. Innovations in mechanized production-control systems are also contributing significantly to efficient job-shop operations.

Statistical evaluation presents yet another management tool. Statistical techniques have proved valuable in quality control problems, particularly in enabling isolation of defects. A method for use of statistically designed experiments was also described.

Why Productivity?

With advanced techniques in product design, progressive processes and equipment, and enlightened management policies—productivity that will rival our achievements in the past, and those of our competitors as well, is possible.

Production engineers recognize, however, that this productivity is not an end in itself. With characteristic lack of complacence, the engineers invited comments from the outside—from a social scientist and a clergyman. Both agreed that productivity is good, but not *the* good. They suggested that productivity is a tool not to be wasted on trivialities, but as a means of enriching the lives of individuals through utilization of its products.

Postprandial Prophets

Luncheons and banquets at technical conferences are usually made distinct by the informal companionship of a "table of eight" and by the thoughts of the one featured speaker.

Speakers at luncheons were: Richard S. Latham, partner, Latham, Tyler, Jensen Design, Chicago, Ill.; L. R. Cook, assistant vice-president, Engineering Division, Western Electric Company, New York, N. Y.; and Ralph Cross, executive vice-president, The Cross Company, Detroit, Mich.

Mr. Latham described "Industrial Design Trends Affecting Engineering for Productivity." Using illustrations, he showed the distortions which occur in product design as a result of a narrow view taken by any one phase of production operations.

Mr. Cook cited engineers as the greatest of "Untapped Sources of Productivity." Tapping this source, he suggested, involves proper organization of engineering work; the breaking of the barriers of the organization chart permitting the cross flow of information; and fostering of a climate of individual awareness of technological changes.

Mr. Cross in a discussion of "Planning for Automation" enumerated the requisites of a sound automation program. Automation provides a tool which can increase productivity, reduce costs, expand markets, and create jobs. Why then are we in this country not automating faster? Mr. Cross conceded that we need better planning, and offered a practical planning checklist.

Robert M. Critchfield, vice-president, General Motors Corporation, Detroit, Mich., was the featured banquet speaker. Mr. Critchfield noted the "Manufacturing Challenges" in the areas of materials, machines or manufacturing facilities, and manpower utilization. He offered standardization of various types of commonly used machine tools as an important challenge to better manufacturing facilities.

He pointed also to the need for drawing-dimension standards and the adoption of the decimal-inch system of dimensioning drawings. In conclusion, Mr. Critchfield said, "We are facing an era of unprecedented growth in our nation and its economy. . .I am. . .certain that we will meet these challenges for a better world tomorrow."

Production Line

Much is to be gained from hearing about and reading about production. But seeing is believing! Just about one car a minute *does* roll off the final assembly line at the River Rouge Plant of the Ford Motor Company. And that dented fender which becomes a bone of heated contention in family circles, all began as a too-hot-to-handle

steel ingot. Plant trips showed the group a complete car assembly at the Ford River Rouge plant. The steelmaking process, from open-hearth furnaces through blooming and rolling mills and on to the stamping plant, was also seen.

A visit to the Plymouth Engine Plant, one of the most automated plants in the world, was visible proof of automation in action. The plant has a capacity of 150 engines an hour and performs all operations from machining of the cast engine block to complete assembly and testing of the engine.

Another group visited the General Motors Technical Center and there saw parts of the GM research, styling, engineering, manufacturing development, and service facilities.

Availability List—Production Engineering Conference

THE papers in this list are available in separate copy form until March 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten are $3 to members; $6 to nonmembers.

59—Prod-1 The Influence of Surface Residual Stress on Fatigue Limit of Titanium, by E. C. Reed and J. A. Viens

59—Prod-2 Shear Spinning, by B. N. Colding

59—Prod-3 Shear-Zone Size, Compressive Stress, and Shear Strain in Metal Cutting and Their Effects on Mean Shear-Flow Stress, by Dimitri Kececioglu

59—Prod-4 1958 Review of Metal Processing Literature (Grinding), by George Reichenbach

59—Prod-5 1958 Review of Metal Processing Literature (Plastic Working), by F. W. Boulger

59—Prod-6 1958 Review of Metal Processing Literature (Metal Cutting Analysis), by J. M. Galimberti, R. S. Hahn, H. J. Siekmann, and E. G. Thomsen

59—Prod-7 Management Implications of Production Controls . . . Planning a New Plant, by V. C. Peterson

59—Prod-8 Product Reliability Measurement, by D. F. Flanders

59—Prod-9 Electrical Discharge Machining as Applied to Engineering for Productivity, by A. E. Holm

59—Prod-10 Process Analysis via Simulation, R. W. Metzger

59—Prod-11 The Organization of Central Stores and Dispatch Systems for Productivity . . . A Solution to Some of the Problems of Job Shop Manufacture, by W. P. Dugan

59—Prod-12 Chipless Forming of Toothed Parts by Rolling, by H. Pelphrey

Automatic Techniques Spur Progress in Industry

Joint AIEE-ASME-IRE Conference, Chicago, Ill., May 11–13, 1959

AUTOMATION and its successful application in fields as diverse as banking, steelmaking, mail handling, and railroading was the subject of the Second Annual Joint Conference on Automatic Techniques. The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Institute of Radio Engineers were joint sponsors of the conference. Meeting place was the Pick-Congress Hotel, Chicago, Ill., from May 11–13, 1959.

Automation and Steel

Steelmaking is gradually increasing its dependence upon automatic techniques for improved and increased steel production. Present accomplishments and future trends for data logging and programming techniques in steel-mill areas of reversing hot mills, tandem hot and cold mills, and processing lines were reviewed by R. W. Barnitz, Jones & Laughlin Steel Corporation, Pittsburgh, Pa., and G. E. Terwilliger, General Electric Company, Schenectady, N. Y. They described the various systems, and discussed operating experience and reliability.

Shaping of steel in a programmed mill was explained by H. G. Frostick. Although massive machines and great blocks of power are used, the shaping must be done at the elevated temperature at which steel is plastic. Thus shaping steel which is a race against heat loss, is achieved by programming huge machines and great masses of material through a process which requires carefully controlled split-second movements. The passage of material between the mill rolls, the positioning of these rolls, the positioning of the material in front of the rolls, and the acceleration and deceleration of the mill rolls and the table rolls which carry the product, all are parts of programming the shaping of steel.

Carl Zimmerman, Mem. ASME, reviewed steelmaking processes in terms of rapidly expanding technological advances in the areas of mechanization, automatic feedback control, integrated data processing, and computer techniques. Mr. Zimmerman emphasized the importance of the systems engineering approach and co-ordinated planning in defining logical areas of application and developing control systems concepts, investment costs, and economic justification.

Automation and Manufacturing

"Numerical control is a simple but wonderful tool that serves to extend the benefits of automatic manufacturing into the realm of low or medium-volume output," according to W. E. Brainard, Kearney & Trecker Corporation, Milwaukee, Wis. Mr. Brainard emphasized that numerical control is not synonymous with computers and complex programming, but a simple method of controlling manufacturing machines so that they respond to instructions in the form of numbers. Among the advantages of the application of numerical control are: Reduced labor, inspection, and tooling costs; consistent accuracy; less control and accounting; fewer machines; improved products; and more profits.

C. N. Bell and I. L. Hosek, Ford Motor Company, Cincinnati, Ohio, presented information related to an initial decision to equip transfer machines with static rather than magnetic controls. The original problems of design, installation, and training for maintenance as well as current operating experiences and characteristics were reported.

"Equipment becomes useful only through the alchemy of the business process. It must be bought and paid for, and put to work before its benefits are realized." W. W. Kuyper, Mem. ASME, discussed the financial justification of automatic equipment in terms of the business in which it is employed. Examples of analyses of specific, large, individual projects typical of automatic equipment were treated.

Automatic Handling

Job shops present unique materials-handling problems. W. M. Willitts, Western Electric Company, North Andover, Mass., demonstrated how, through careful analysis of operations as well as environmental conditions, mechanization of the job shop can be affected.

"Automation in Railroading," according to V. E. McCoy, Chicago, Milwaukee & Pacific Railway Company, Chicago, Ill., dates back to the application of

the air brake. When the engineer by moving a simple lever, could apply brakes simultaneously to all cars in his train—that was the start of automation. The railroad industry has continued to automate through application of centralized traffic control, electronically operated yards, and automatic processing of accounting operations.

A modern semiautomatic conveyer arrangement is facilitating mail handling in local post offices. The Mail-Flo System, described by S. C. Skeels, U. S. Post Office Department, Washington, D. C., is an integrated arrangement of conveyers and control equipment which automatically transports batches of letter-size mail in trays on conveyers from one floor station to another.

Automated Business Procedures

B. W. Taunton, First National Bank, Boston, Mass., described automatic techniques which apply to banking procedures. Included in the discussion were the procedures followed in selecting the computer as well as selection and training of personnel to program and operate the system. "Businessmen should not arbitrarily assume that their organizations are 'too small' to make it economically feasible for them to use these tools [electronic computers]."

Development of magnetic ink character-recognition equipment has removed one of the impediments to the use of high-speed automation equipment in banking. W. F. Prince, General Electric Company, Phoenix, Ariz., described an automatic high-speed bank system which employs magnetic ink characters as the common machine language.

"Data Processing—Its Role in Administration," was investigated by J. D. Gallagher, Sylvania Electric Products Co. Mr. Gallagher described his company's data processing system which was designed as a service activity with the primary responsibility of supplying all levels of management with timely information in order to facilitate decision making.

Automating Process Industries

"Automatic optimization is one of the newest concepts in the field of process control." The optimizing control system considered by D. A. Burt, Westinghouse Electric Corporation, Pittsburgh, Pa., was developed to imitate thinking procedures, memory, and actions of a human operator in controlling a multivariable process. OPCON, the Westinghouse trade name for the system, has as its basis a transistor-resistor logical system which makes changes in the controlled variables, observes results, and decides what to do next to improve operations.

Use of data logging in chemical processing was described by G. P. Russell and T. J. Shuff, Monsanto Chemical Company, St. Louis, Mo.

P. D. Schnelle of the E. I. du Pont de Nemours & Company, Wilmington, Del., considered data gathering in continuous chemical processing.

Availability List—ASME-AIEE-IRE Conference on Automatic Techniques

THE papers in this list are available in separate copy form until March 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. Postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

59—AuT-1 Mechanization of the Job Shop, by W. N. Willitts

59—AuT-2 Static Control and Automatic Transmissions, by C. N. Bell and I. L. Hosek

59—AuT-3 Application of Numerical Control for Automatic Manufacturing in General Industry, by W. E. Brainard

59—AuT-4 An Optimizing Control for the Process Industries, by D. A. Burt

59—AuT-5 Application of Data Logging and Programming Techniques in Steel Processes, by R. W. Barnitz and G. E. Terwilliger

59—AuT-6 Productivity Improvement Through Automatic Control Techniques, by Carl T. Zimmerman

Cleveland Industry's Market Place for Four-Day Material Handling Institute's Exposition

THREE days of technical sessions on the management, engineering, and application techniques for industrial materials handling were held in conjunction with The Material Handling Institute's Exposition of 1959, June 9-12, at the Cleveland, Ohio, Public Auditorium. The American Society of Mechanical Engineers and the Society for Advancement of Management were co-operating societies with the American Material Handling Society, Inc. Each organization sponsored a panel-type technical-paper presentation on one of the topics.

Four ASME papers were presented on the engineering aspects of mechanized freight handling at railroad terminals, the containerizing of ships' cargoes, coal-handling facilities at a power-generating station, and engineered case handling in a modernized brewery.

The railroad terminal was the N. Y. Central's portion of the Port of New York. The specialized marine-service facilities for railside-shipside deliveries were described. Lighterage, sea-trains, carfloats, and the facilities for such commodities requiring individualized handling as grain, cement, and newsprint were described. The railroad's marine-service facilities—largest of their kind—include a marine fleet of 273 units with tugboats, floating derricks, scow barges, refrigerator-heater barges, and carfloats. This is the most costly part of the Central's total New York City freight-handling operations employing 2000 with an annual payroll of about $8 million. Some materials-handling improvements have been completed recently.

Coal handling at Philadelphia Electric's supercritical plant required a 300,000-ton coal-storage pile (60 days burn at 5000 tons a day) for the two 325,000-kw cross-compound turbine-generator units. All coal is received by rail, and rotary car dumpers feed it into a complex automatic conveyer system which includes crushing, reclaiming, and sampling operations. The unloading is based on one shift a day and a 5-day week. Philadelphia Electric's experience with coal handling at other stations has been so satisfactory that oil as a back-up fuel was eliminated from the final design.

Palletized handling for breweries is complicated by glass bottles for part of the stock, limitations on stacking height because the seal of the crown might be affected by too much weight, stock-rotation problems, and the complaints which arise from damaged containers. Within these limitations considerable manual handling has been eliminated.

The fourth ASME paper was not available.

Three years of progress for the material-handling industry, since the last national exposition in 1956, were displayed at the Material Handling Institute's Exposition in 38 categories of industrial material-handling equipment made by over 200 manufacturers. Typical of the products and systems displayed were industrial lift trucks, conveyer and monorail systems, racks, pallets, mobile cranes, industrial trailers, and metal containers. An interpreting service and a reception room were provided for visitors from Europe and South America.

Conducted for the National Junior Committee

A. S. GOLDSTEIN

JUNIOR FORUM

Preparation of Papers for ASME Publications

By A. S. Goldstein

In the April issue of MECHANICAL ENGINEERING the Junior Forum published an informative article by A. T. Wuska about ASME publications. In order to complement Mr. Wuska's article the Junior Forum now presents for the benefit of associate members a discussion of how to prepare a paper for ASME publications.

General Information

Since the main purpose of presenting a paper is to convey information to others, the anticipated audience dictates the style of writing and the method of presentation. It is usually a good policy to write for the average engineer and not a specialist in your field. Use of the third person is recommended and references to individuals and companies should not be made in a manner which may produce personal bias.

As a rule, the text of an ASME paper should not exceed 4000 words (about 14 pages of double-spaced typescript). Visual aids and detailed analyses are to be included in a paper only when they are necessary to clarify the meaning or demonstrate results properly. It is the author's responsibility to obtain all company approvals and government clearances. It is a good idea to indicate that these approvals have been obtained when submitting a paper.

Contents of the Paper

The ASME recommends that the desired order of contents of a paper be as follows:

Title—should be explicit, descriptive, and brief.

Author's Name—should appear immediately below the title at the top of the first page. The business connection should appear as a footnote at the bottom of the first page.

Abstract—should present a clear indication of the object, scope, and results. An abstract is usually 50 to 100 words and should precede the body of the paper.

Body of the Paper—should be organized logically and presented in an orderly form.

Appendixes—should be used for necessary information not essential to the general presentation of the subject.

Acknowledgments—should appear at the end of the text preceding the bibliography.

Bibliographies—should be used if there are more than five references. Otherwise use footnotes. Accuracy is extremely important when using references.

Photographs and Illustrations—prints should be clear and sharp with a glossy finish and all illustrations in reproducible form.

Writing the Paper

One of the most important means of obtaining proper recognition and attention to the results of your efforts is the written word. Good writing stems from proper training and experience, and most successful engineers are good writers. The ASME offers an opportunity for all associate members to obtain the experience of preparing and presenting a paper through its various meetings and professional division conferences.

One essential item in preparing a paper is an adequate outline. In the process of making an outline the author classifies his ideas and places his thoughts into a logical sequence so that he has a good mental picture of what he wants to say and accomplish. A proper outline is the foundation and framework upon which a good paper is readily fabricated.

Submitting and Presenting the Paper

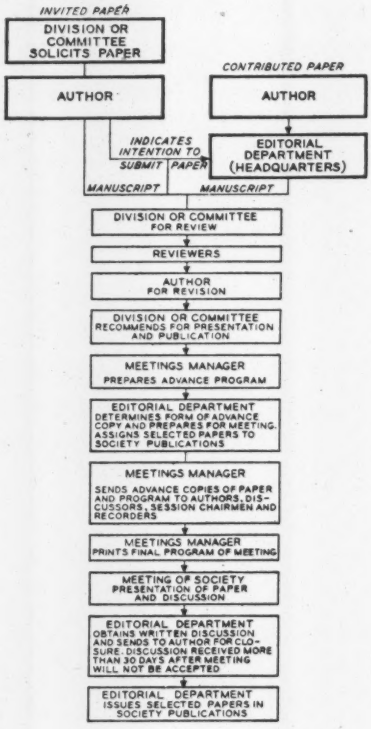
In the ASME there are certain requirements for presenting a paper.

It is emphasized that at least six months prior to a meeting the author must inform both the Division or Committee soliciting the paper and the Meetings Manager of his intention to submit a paper and state at which meeting he desires to present it. The author should submit the proposed title of the paper and brief description of its contents. The manuscript of the paper must be submitted not later than the first of the fourth month prior to its presentation. This will allow for proper review, time for revisions, and printing of papers before the meeting.

A time limit of 15 to 20 minutes is usually allowed for presentation of papers. Papers should not be read in full since this is usually monotonous and time-consuming. Effective presentation like good writing is obtained through proper training and experience. A successful presentation usually covers: (*a*) A clear statement of the problem; (*b*) a brief description of the attack; and (*c*) a forceful review of conclusions.

It is the purpose of this article to present briefly some of the requirements and suggestions of submitting and presenting a technical paper. The ASME has available to members upon request an ASME Manual, MS–4, which contains details and suggestions for submitting and presenting papers. A copy may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Course of an ASME paper from author to publication


INVITED PAPER
DIVISION OR COMMITTEE SOLICITS PAPER
AUTHOR
CONTRIBUTED PAPER
AUTHOR
INDICATES INTENTION TO SUBMIT PAPER
EDITORIAL DEPARTMENT (HEADQUARTERS)
MANUSCRIPT
MANUSCRIPT
DIVISION OR COMMITTEE FOR REVIEW
REVIEWERS
AUTHOR FOR REVISION
DIVISION OR COMMITTEE RECOMMENDS FOR PRESENTATION AND PUBLICATION
MEETINGS MANAGER PREPARES ADVANCE PROGRAM
EDITORIAL DEPARTMENT DETERMINES FORM OF ADVANCE COPY AND PREPARES FOR MEETING. ASSIGNS SELECTED PAPERS TO SOCIETY PUBLICATIONS
MEETINGS MANAGER SENDS ADVANCE COPIES OF PAPER AND PROGRAM TO AUTHORS, DISCUSSORS, SESSION CHAIRMEN AND RECORDERS
MEETINGS MANAGER PRINTS FINAL PROGRAM OF MEETING
MEETING OF SOCIETY PRESENTATION OF PAPER AND DISCUSSION
EDITORIAL DEPARTMENT OBTAINS WRITTEN DISCUSSION AND SENDS TO AUTHOR FOR CLOSURE. DISCUSSION RECEIVED MORE THAN 30 DAYS AFTER MEETING WILL NOT BE ACCEPTED
EDITORIAL DEPARTMENT ISSUES SELECTED PAPERS IN SOCIETY PUBLICATIONS

[1] Engineering writer, General Electric Advanced Electronics Center at Cornell University, Ithaca, N. Y. Assoc. Mem. ASME.

August 9–12

ASME-AIChE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

September 9–11

ASME Applied Mechanics Western Conference, Stanford University, Stanford, Calif.

September 10–12

ASME, AIChE, FPRS Wood Industries Conference, Multnomah Hotel, Portland, Ore.

September 17–18

ASME-AIEE Engineering Management Conference, Statler Hilton Hotel, Los Angeles, Calif.

September 20–23

ASME Petroleum Mechanical Engineering Conference, Rice Hotel, Houston, Texas

September 27–October 1

ASME-AIEE National Power Conference, Hotel Muehlebach, Kansas City, Mo.

ASME COMING EVENTS

October 20–22

ASME-ASLE Lubrication Conference, Hotel Sheraton-McAlpin, New York, N. Y.

October 26–29

ASME-AIME Fuels Conference, Netherland Hilton Hotel, Cincinnati, Ohio

November 4–6

ASME-IRE-AIEE-ISA National Automatic Control Conference, Sheraton Hotel, Dallas, Texas

November 8–13

ASME, ASTM, ACS International Rubber Conference, Shoreham and Park Plaza Hotels, Washington, D. C.

November 16–20

ASME Materials Handling Conference, New York Trade Show Building, New York, N. Y.

November 29–December 4

ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

(*For Meetings of Other Societies, see page 95*)

NOTE: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

ASME CODES AND STANDARDS WORKSHOP

Revised American Standard on Reamers (ASA B5.14-1959)

By C. J. Oxford, Sr., Chairman, B5 TC20

A revised edition has just been issued, bringing this standard up to date.

The principal revisions are in the areas of nomenclature and the addition of standards for a greatly extended series of high-speed steel straight shank reamers.

The nomenclature has been revised to conform to that used in the revised standards for other metal-cutting tools such as twist drills, milling cutters, and taps.

Minor corrections have been made in tables of sizes and types, as well as in tolerances of various elements, to reflect current requirements in their field.

Copies are available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Interpretations of 1955 Code for Pressure Piping

FROM time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1–1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Cases 38 (reopened) and 41 are published herewith as interim actions of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Case No. 38 (Reopened)

Inquiry: May piping components made on Nodular Cast Iron and to the dimensions of ASA Standards B.16.1, B.16b and B.16.5 be used in construction under the jurisdiction of Sections 1, 2 and 3 of the Code for Pressure Piping (ASA B31.1–1955)?

Reply: It is the opinion of the Committee that, pending the completion of studies now in progress in Sectional Committee B16 and B31, Nodular Cast Iron components made of material conforming to ASTM Specification A395–56T may be used under the Sections indicated in the Inquiry under the following conditions:

(a) Components whose dimensions conform to ASA B16.1 and B16b may be used at the following maximum pressure temperature ratings at temperatures between minus 20 F and 650 F.

DIMENSIONS USED	MAXIMUM RATING
Class 125 C.I. (B16.1)	80% of 150 lb Carbon Steel (B16.5)
Class 250 C.I. (B16b)	80% of 300 lb Carbon Steel (B16.5)
150 to 600 lb Steel, inclusive (B16.5 or API 600)	80% of Carbon Steel rating

These ratings are applicable to values providing that the values in other respects merit these ratings. It is recognized that components made to the Class 125 and Class 250 standards or to API Std 600 may be thicker than those made to the 150-lb and 300-lb standards, respectively. In the case of these thicker components the additional wall thickness may be considered as additional corrosion allowance.

(b) Until further experience is developed, the pressure at operating temperature shall not exceed 1000 psi.

(c) Welding of the components is not employed in fabricating them in an assembled system.

(d) They shall not be used in lethal service, as defined in each of the Sections indicated in the Inquiry.

Case No. 41

Inquiry: Paragraph 632 Sub 4 is some-

what more restrictive than the requirements of other codifying bodies. Under what circumstances may stress relief be omitted on chromium molybdenum steels?

Reply: It is the opinion of the Committee that for applications under Section I of the Code and under Paragraph 632 Sub 4 the following need not be stress-relieved:

Chromium-molybdenum steels with a maximum specified chromium content of 3 per cent and a maximum outside diam of 4 in. and a maximum thickness of less than $^1/_2$ in. Circumferential joints in the pipe or tubes of the "P" No. 4 steels shall be preheated to 250 F min. and the "P" No. 5 steels shall be preheated to 300 F min.

Cases Annulled

Case No. 9	Eliminate inconsistency
Case No. 24	Incorporated in B31.8-1958
Case No. 31	Incorporated in B31.8-1958

B31.8 Revision Published

The latest edition of American Standard Code for Gas Transmission and Distribution Piping Systems, ASA B31.8–1958, has been approved by the American Standards Association and published by The American Society of Mechanical Engineers.

The new edition brings the code up-to-date, incorporating many of the rulings that had been made in the form of cases since 1955, when the first edition of this standard in its enlarged scope was published. Numerous revisions also have been made to clarify certain sections and for uniform interpretation and usage.

This code is Section 8 of the American Standard Code for Pressure Piping, which is directed by ASA Sectional Committee B31. This committee, sponsored by ASME, has established an orderly procedure for revision of the code through the issuance of "cases." These are the committee's replies, published in MECHANICAL ENGINEERING and in the *Magazine of Standards*, to requests it has received for interpretation.

Section 8 covers minimum requirements for the design, fabrication, installation, inspection, testing, and for the safe operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor stations, gas metering and regulating stations, gas mains, and gas services up to the outlet of the customer's meter.

The Code for Pressure Piping deals primarily with engineering requirements for safe design and construction of piping systems. The committee points out that it is not a design handbook, but that it does contain basic reference data and formulas necessary for design.

While the work on the American Standard Code for Pressure Piping dates back to 1926, section 8 was not published separately until 1952. The purpose was to provide an integrated document for gas transmission and distribution piping that would not require cross-referencing to other sections of the code. A new subcommittee was organized in 1952 to amplify section 8 as new materials and methods of construction and operation made it necessary.

In 1955 the subcommittee revised the 1952 edition and considerably expanded its scope. Further experience in the application of the code resulted in revisions which the subcommittee incorporated in the new edition just published.

F. S. G. Williams, general chairman of the ASA B31 committee, said in announcing the new edition that the American Gas Association was responsible for substantial support and staff assistance to the section 8 committe.

Much of the subcommittee's work is based on research conducted by the American Gas Association and the ASME Pressure Vessel Research Committee. Chairman of the subcommittee is John H. Carson, vice-president of The East Ohio Gas Company, Cleveland, Ohio. The subcommittee has a membership of approximately 70 engineers drawn from design, engineering, construction, operation, and testing, and also includes several nationally recognized technical consultants.

Copies of American Standard Code for Gas Transmission and Distribution Piping Systems, ASA B31.8–1958, are available at $2.50 a copy from Order Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society on Friday, May 8, 1959. There were present: G. B. Warren, Chairman; E. W. Allardt, L. N. Rowley, and R. B. Smith, of the Executive Committee; Joseph Pope, a director; E. J. Kates, treasurer; H. J. Bauer, assistant treasurer; L. C. Smith, chairman, Organization Committee; W. F. Thompson, ASME Representative to UET; C. E. Davies, secretary-emeritus and executive director, United Engineering Center Project; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; W. E. Letroadec, W. E. Reaser, S. A. Tucker, and J. D. Wilding, assistant secretaries; J. J. Jaklitsch, Jr., editor; H. I. Nagorsky, controller; D. B. MacDougall, associate head, Field Service.

The following actions of the Council are of general interest:

Board on Honors. At its April 23, 1959, meeting the Board on Honors approved the recommendations of the Medals Committee that the following honors be given for 1959: Holley Medal to Colonel Maurice J. Fletcher; Timoshenko Medal, Sir Richard Vynne Southwell; Machine Design Medal, Charles E. Crede, Mem. ASME; Worcester Reed Warner Medal, Samuel Glasstone; Melville Medal, Stephen J. Kline, Mem. ASME; Prime Movers Committee Award, J. Kenneth Salisbury, Fellow ASME; and Junior Award, Victor Salemann, Assoc. Mem. ASME. The Blackall Machine Tool and Gage Award will not be given in 1959. M. Eugene Merchant, Mem. ASME, was named for the Richards Memorial Award; Pi Tau Sigma Gold Medal Award, Donald F. Hays.

The Council approved the establishment of the Machine Design Medal.

On recommendation of the Board on Honors, the Council approved the following topics for the Charles T. Main Award. For 1960, "A Program for Continuing Broad Self-Education for the Engineering Graduate"; and for 1961, "What Are the Potentialities of Honor Societies as They Affect Engineering Education?"

Research Agreement. The Council authorized the extension agreement (April 10, 1959) with Battelle Memorial Institute (DP11 and DP13) for the continuation of the collection of high-temperature data and the preparation of the data for punch-card distribution for the

Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals for a period of six months ending Oct. 31, 1959.

Sections. The Council, upon recommendation of Vice-President Coogan, approved the formation of a Vermont Group of the Northern New England Section. Burlington is to be headquarters city.

Upon recommendation of Vice-President Grasse and approval of the South Texas Section, the Council authorized the formation of the Austin Group, territory of Travis County, of the South Texas Section.

Eastern Group of the Northwest Florida Section was authorized upon the recommendation of Vice-President Little. Panama City will be headquarters city.

Ohio Valley Subsection of the West Virginia Section, with Parkersburg as headquarters city, was authorized by the Council upon recommendation by Vice-President Allardt.

The Council authorized the transfer of Cape Girardeau County, Mo., from the St. Louis Section to the Paducah Subsection of the Louisville Section upon recommendation of Vice-President Dolan.

Promotional Material. The Council approved the distribution of the pamphlet, "Mechanical Engineering and You," as prepared by the Region V Publications and Public Relations Committee to high-school students in Region V; also to refer the pamphlet to the Board on Education for consideration of its adoption as a Society publication for use nationally.

Metals Engineering Handbook Board. The Board on Technology approved the request of the Metals Engineering Handbook Board to change its name to Metals Engineering Handbook Managing Committee as being more descriptive of its activities and responsibilities and less confusing with respect to the Society's organizational structure.

Certificates of Award. The following certificates of award were approved: Section Chairmen, 1957–1958—Lester M. Finch, Columbia Basin; Eugene Linsker, Dayton; Glen H. Howell, Detroit; John Parmakian, Rocky Mountain; John R. Buss, St. Louis; Benjamin F. King, West Virginia; and Walter J. Govoni, Western Massachusetts. Section Chairmen, 1958-1959—John W. Walker, Central Savannah River Area; and Thomas W. Hopper, Philadelphia. Past-chairmen of the West Virginia Section, Dale C. Calhoun, 1955–1956, and Louis H. Benner, 1956–1957, also were granted certificates of award.

Also approved were certificates of award for the following: Donald Taylor, Worcester Member Gifts Campaign Chairman; and S. A. McKee, member from 1945 to 1959 of the Research Committee on Lubrication.

Presidential Appointments. The following presidential appointments were reported:

Constitutional Amendments Tellers included F. E. Lyford, F. B. Turck, and C. G. Worthington.

M. V. Maxwell, 1959 Washington Award Dinner, April 13, 1959, Chicago, Ill.

Dean James H. Potter, Rutgers University, New Brunswick, N. J., May 6, 1959, inauguration of President Mason Welch Gross.

An Advisory Committee on Unity composed of two vice-presidents, two directors, an EJC representative, an ECPD representative, chairman of the Organization Committee, and the Junior past-president has been appointed by President Warren. The personnel of the Committee for 1959 includes: R. B. Smith, *chairman;* E. W. Allardt; E. J. Kates; J. N. Landis; W. H. Larkin; J. W. Little; L. C. Smith; V. W. Smith; and Joseph Pope, Alternate.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	57 Post St.

Men Available[1]

Export Sales Engineer, BS and MS (ME); MS (Bus. Adm.); 29; four years' experience capital goods, in charge liaison and research overseas, license negotiations abroad; also promotion and sales abroad, excellent contacts in Europe. Speaks four languages. Seeks responsible position international division or branch overseas. Me-728.

Mechanical Engineer, BSc, June, 1959; interested in equipment design, topographical surveying, or equipment maintenance. Prefers North or South America. Me-729.

Mechanical Engineer, BSE; 40; 19 years development of small precision mechanical product; four years engineering management. Holds patents. Goal is position as chief engineer of small to medium company. Prefers New York, Midwest, or New England. Me-730.

Engineering Management, BSME; 35; administrative engineer, 13 years' experience, research and development, promotion, supervising, training, planning, testing, designing, budget control. Gas-turbine field. Assistant to director of research, manager, gas-turbine test plant. Considerable contact with subscribing company executives. Seeks challenging and responsible managerial position with company with growth potential. Location immaterial. Me-731.

Engineering Operation and Planning, BSME; 44; 11 years electric-utility planning, operation, maintenance in generation, transmission, distribution. Location immaterial. Me-732.

Administrative Engineer, more than 20 years' experience as chief Draftsman of group of 75, engineering manager of group of 40. Experience in organization, planning, cost reduction, human relations, etc. Prefers Philadelphia, Pa. area. Me-733.

Chief Industrial Engineer, BS and MS IE; 33; 3½ years chief industrial engineer for methods, time standards by MTM and quality control and over-all industrial-engineering functions; six years over-all industrial-engineering functions for both small lot and mass production including four years' wage incentives. Location immaterial. Me-734.

Engineering Management or Teaching, ME degree; 34; 13 years in design and development of product, process, and machinery in consumer uses, including paper, plastic, and foil materials for high-volume production. Me-735.

Project or Plant Engineer, BS(ME); 45; PE; extensive, diversified experience in chemical and associated industries. Experienced in supervision and in design, project, plant, and equipment engineering. Able to work with people with widely varying backgrounds. Location immaterial. Me-736.

Senior Mechanical Engineer, BS, 1950; 42; piping engineer, five years; valve industry from shop, one year, to drafting to product engineer, nine years; mechanical design of nuclear reactors and coolant system, four years. Major field in "hardware" and systems requiring knowledge of stresses, fluid flow, heat transfer, materials application, and code design. Prefers East. Me-737.

[1] All men listed hold some form of ASME membership.

How Well Do You Know Your Society?

So THAT the members of ASME may know their Society, attention is called to the list of Manuals and Annuals available upon request from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Unless otherwise noted, all the items in the list will be sent without charge, one copy of each per member.

AC 2 Annual Report of ASME Research

AC 10 Personnel of Council, Boards, and Committees

AM 1 Membership List—Alphabetical and Geographical (Biennial — odd-numbered years)

AM 3 Catalog of Publications (also included in "Mechanical Catalog")

AM 4 Members List—Listed by Companies (Biennial—even-numbered years, $2 each)

AM 5 Indexes to ASME Papers and Publications

MM 1 Certificate of Incorporation, Constitution, By-Laws, and Rules

MS 4 An ASME Paper (50 cents to nonmembers)

MS 61 Citizenship and Participation in Public Affairs

Design Engineer or Mechanical Consultant, BSME; 29; professional engineer; 6½ years design, drafting, and specifications of: Plumbing, heating, air conditioning of industrial, municipal, and commercial buildings. Boiler-water treatment; municipal water supply and treatment; swimming pools; gas-distribution system; steam-distribution system; some electrical of buildings and reports. Prefers U. S. Me-956-Chicago.

Research and Development Engineer, BSE; 31; headed product-development department for large plumbing manufacturer. Worked on hydraulic, electric, and plastic components. Considerable acoustics and managerial experience. $11,000. Prefers Chicago or West Coast. Me-957-Chicago.

Works Manager or Director of Industrial Engineering, BSEE; 53; PE; 31 years' experience plant operation, all functions of industrial engineering including budgetary and expense control, standard costs, labor relations, production and inventory control, executive procurement and training, organization, policy. Multiplant experience and 12 years' professional experience. Will relocate; presently in Ohio. Me-955-Chicago.

Industrial Engineer or Production Supervisor, BSME, BS, Bus. Adm.; 32; ten years' industrial-engineering experience; five years with management consulting firm. Background in food preparation and corrugated containers. Proved ability of completing assignments on schedule; capable, industrious, personable. $7200. Prefers West, Midwest, or Foreign. Me-958-Chicago.

Project or Sales Engineer, BSME; 29; PE; nine years' experience extensively in development, application, and projects engineering. Much administration and supervision background. Customer contact. Broad experience in high-vacuum equipment and all phases of ferrous and nonferrous melting and processing equipment. Desires responsible growth position in sales, project management, or as executive assistant. Prefers Midwest. Me-960-Chicago.

Mechanical Engineer; 54; engineering graduate, 22 years development of mechanisms, structures in industrial applications, freight cars, automobiles; eight years mechanical analysis design, installation, testing aircraft, engines and gas turbines; 13 years supervision. Location, immaterial. Me-962-Chicago.

Positions Available

Works Manager, engineering degree and at least ten years' supervisory industrial-engineering and production experience in primary metal mill covering sheet, strip, tubing, wire goods, etc. $20,000. Midwest. W-7405.

Director of Management Development, college graduate, for firm doing research and development and production in the missile and airframe industries. Will formulate and implement expanded program of executive, supervisory, and personnel development at the corporate level. Should know and be experienced in policy determination for corporate personnel-development programs. $20,000 a-year-range, plus attractive benefits. Some travel between plants. Far West. W-7423.

Senior Industrial Engineer, degree in industrial engineering, or management with advanced course in industrial engineering, at least three to five years' industrial experience. Any experience in indirect labor incentive will be helpful; also with standard data. Duties will include establishing time standards, administering incentive system, administering job-evaluation plans, suggesting improvement in processing and packaging operations. Salary open. Central N. J. W-7426.

Design Engineers, graduate mechanical or civil, for the design, construction, maintenance, and modification of a variety of mineral-processing plants, from small pilot plants to full-scale installations. Work requires engineering ability in many fields, with responsibility assigned as rapidly as individual capability will permit. Excellent opportunities for advancement. Salary commensurate with experience and responsibilities. South. W-7444.

Research Engineer, mechanical graduate, advanced study desired, to guide research programs, analyze experimental results, and consult on advanced engineering problems dealing with steam generators and nuclear components. Specific areas where work is to be done include industrial and utility-furnace radiation, radiation and convection in tube-banks, conduction in oddly shaped geometries, boiling heat transfer at high qualities, etc. Salary open. Midwest. W-7445.

Engineers. (*a*) Senior engineer, automotive division, graduate mechanical or electrical, with three to five years' experience in design for mass production of industrial controls—relays, small switches, or solenoids. (*b*) Senior engineer, consumers' product division, to conceive and design new products, watch costs in air moving devices; i.e., fans, ventilators, and other new consumers' products or appliances. (*c*) Senior engineer, motor division, for research and development in the manufacture of fractional hp motors. Could have experience in any traffic appliances but a keen interest in small motor design. $8500-$11,000. Company will pay placement fees and moving expenses. N. Y. State. W-7448.

Project Engineers. (*a*) Project engineer, mechanical or chemical graduate, ten years' general experience in plant and project engineering in the heavy chemical-operating industry, to co-ordinate plant engineering and new construction projects in central engineering staff. $12,000-$15,000. Some travel. New York, N. Y. (*b*) Project engineer, mechanical or chemical graduate, four to eight years' experience in plant and project engineering in regard to mechanical equipment in multiunit chemical plant. To $10,000. (*c*) Chief plant engineer, 15 years' experience in plant-engineering, maintenance, and modification of equipment, heavy chemicals. Must be a good administrator. $12,000-$15,000. Central Ill. W-7458.

Project Engineer, graduate mechanical or equivalent, five years' experience in product design and development. Strong on creative ability. Must be cost-conscious and have practical knowledge of metalworking operations. Should have ability to handle development projects from project definition through the pilot stage. Western Pa. W-7459.

Engineers. (*a*) Chief engineer, mechanical or chemical graduate, eight years' experience, a minimum of five years in paper industry, to select, design, procure, construct plant equipment, lay out, install new equipment, all maintenance and maintenance costs for a two-plant operation. $11,000-$12,000. (*b*) Industrial engineer, five to ten years' experience in production, methods, time and motion study, new equipment, material-handling studies in a paper and paper-board manufacturing plant. $10,000-$12,000. W-7465.

Sales Trainer, electrical or mechanical graduate, three to five years' field sales and application engineering covering relays and signaling systems, to train manufacturers' agents covering estimates, specifications, etc. Considerable traveling through U.S. $8000. Headquarters, N. J. W-7467.

Engineers. (*a*) Market manager, actually a staff sales manager for the sales of noncontact gages. Establish new product lines, sales policies, etc. Northern N. J. (*b*) District sales manager, general sales experience in instruments as applied to industrial equipment. 100 miles of New York City. (*c*) Distributor sales manager familiar with instrument-control equipment and particularly with distributor management setup. Northern N. J. Salaries open. W-7471.

Engineers. (*a*) Chief of production planning and control, college graduate, BS or Production Management, experienced in production planning, inventory control and scheduling, to supervise the plant scheduling, dispatching, stockroom and inventory-control functions. To $8400. (*b*) Project engineer, industrial, graduate industrial engineer, knowledge of tooling or tool engineering highly desirable, experience in methods, development of labor standards, and incentive rates by time study and/or predetermined times, job evaluation, and cost-analysis work. Under general direction, will develop, co-ordinate, and administer major projects, for the control and reduction of all elements of manufacturing costs. Salary open. Pa. W-7490.

Engineers. (*a*) Industrial engineer, IE degree, and a few years' experience in related industrial-engineering activities; tooling knowledge or experience helpful. Should have potential to assume more responsibility in future. To $10,000. (*b*) Designer experienced in design field of intricate mechanisms, blanking, and forming, automatic assembly equipment. Must have potential for advancement to engineer status. To $8400. Pa. W-7491.

Machine Designer, graduate mechanical, eight to ten years' experience in machine design, to design and follow through the construction of highly specialized equipment. Equipment is used to assemble unique plastic packages and client products. $10,000–$12,000. Company will pay placement fee. Conn. W-7492.

Engineers. (*a*) Manager, budget and cost control, to conduct cost studies, plan programs, and supervise budget and cost-accounting activities for the overhaul depot of an airline. $9300–$11,400. (*b*) Purchasing agent to supervise a staff determining system-inventory requirements for assigned commodity classifications and purchasing items for aircraft and facility maintenance and modification operations. $8400–$10,200. Midwest. W-7498.

Marketing Manager, Commercial Products, degree in Bus. Adm. or engineering essential; graduate work desirable. Must have a minimum of five years' experience in the field of marketing and distribution of control systems or electromechanical components to industrial concerns, principally machine-tool manufacturers. Experience should include supervisory and administrative positions. Familiarity with hydraulic components and a wide variety of manufacturing industries most desirable. Will be responsible for organizing and administering a completely new marketing division. Must be capable of conducting market surveys, establishing pricing and OEM discount policies, and establishing a nationwide distribution and service system. Submit résumé, indicate present salary. Company will negotiate placement fees and relocation expenses. Upstate N. Y. W-7502.

Assistant or Associate Professor of Mechanical Engineering, MS or higher desirable. Salary open depending on experience and background; academic year is nine months. Consulting, research, and development work is permissible and available for extra compensation. Available Oct. 1, 1959. South. W-7504.

Office Engineer, for a firm of mechanical contractors; considerable experience in estimating, pricing, and bidding of plumbing; heating, process piping, ventilating, and air-conditioning projects of industrial types. Experience in administration and management of an office doing between 3 and 5 million dollars. Submit complete résumé including salary requirements. South. W-7506.

Engineers. (*a*) Project engineer, BS or MS in ME, with design training and aptitude to design and develop special fuel-injection nozzles. Two to five years in a field related to the following: (1) Manufacture of small precision parts designed to satisfy exacting performance requirements; (2) hydraulics involving fluid flow and flow metering; (3) thermodynamics, combustion, or flame propagation; (4) instrumentation related to temperature, pressure, flow rate, physical properties of liquids and automatic control. (*b*) Assistant project engineer, recent graduate and/or graduate engineer, one to two years' experience, to assist in the design and development of special

fuel-injection nozzles. Desired experience and/or aptitude as defined in afore-mentioned. (*c*) Research engineer, mechanical or chemical engineer, BS or MS degree and two to five years' industrial experience. Prefer engineer, experience in design and operation of instrumented bench-scale apparatus for studies of fluid flow involving high temperatures and pressures. Background in mechanical design and fuel or spray technology desirable. Salaries open, commensurate with experience, education, and ability; company provides a profit-sharing, retirement plan; insurance benefits. Midwest. W-7522.

Production Supervisor, to co-ordinate the manufacturing in multiplant operation, to obtain maximum production in each shop and watch costs. $10,000–$12,000. Some travel. New York, N. Y. W-7527.

Research Engineer, MS or PhD in mechanical or metallurgical engineering, physics or civil engineering, two to five years' experience preferred, to conduct research in the following areas: Theory of elasticity, theory of plastic flow and fracture, dislocations in crystalline structures, creep, fatigue, and thermal shock. Strong scientific interest; should have kept in forefront in strength of materials and in application to industrial problems. $8500–$12,000. Company pays placement fees. Midwest. W-7530(*a*).

Industrial Engineer, for firm of management consultants, some background in office procedures, warehousing, and materials handling. Any experience in wholesale distribution of plumbing and heating supplies helpful. $10,000–$12,000. Considerable travel. Northern N. J. W-7534.

Mechanical Engineer, experienced in plant maintenance and new construction. Company manufactures electronic-equipment devices, semiconductors, miniature switchgears. $13,000–$14,000. Southwest. W-7535.

Project Engineer, mechanical or chemical graduate, five to ten years' experience in chemical-plant design and construction. Must have previously worked as project engineer. To $13,000. New York, N. Y. W-7536.

Assistant to Industrial-Relations Director, engineering graduate, personnel, technical recruiting, and union-negotiation experience. $8000–$10,000. Metropolitan N. J. W-7537.

Research Engineer, mechanical, for the design and modification of testing equipment used on fibers, yarns, and fabrics. Small equipment design and familiarity with electronic-testing equipment. Salary open. Va. W-7538.

Mechanical-Design Engineer, at least a BS (ME), design, stress analysis, or heat-transfer experience, for design and development of hardware for solid propellant rockets and gas generators. Test and evaluate results. Liaison with customers, hardware suppliers, place orders. Employer will pay relocation expenses and agency fees. Midwest. W-7545(*a*).

Executive Assistant, graduate engineer, managerial and manufacturing experience in plastic fields covering polyurethane products. $10,000. Va. W-7548.

Industrial Engineers. (*a*) Industrial engineer familiar with general machine-shop operations and experience in standard-data development and work measurement. Will direct one to two assistants. $7800, plus. (*b*) Junior industrial engineer capable of making time studies and assisting industrial engineer in the foundry. Some previous foundry experience desirable. $6500, plus. Mass. W-7553.

Development Engineer, graduate, acoustical, vibration, and fluid-flow experience covering compressed gases. Knowledge of intake and discharge silencers desirable. Salary open. Texas. W-7556.

Plant Engineer, mechanical graduate, at least five years' experience supervising maintenance, installation, and construction in metal-products manufacturing fields. $10,000. Upstate N.Y. W-7563.

Sales Manager, mechanical graduate, at least five years' supervisory sales experience covering instruments, liquid-flow meters, and measuring devices. $12,000–$15,000. Eastern Pa. W-7564.

Mechanical Engineer, recent graduate, for a training program which will include some work on the board and some work in the field to familiarize applicant with boilers and stokers. Would prefer two or three years' experience in a field somewhat related. Mich. W-7570.

Engineers. (*a*) General manager, graduate mechanical, at least ten years' experience covering fabrication and production of steam boilers including welding operations. $12,000, plus bonus. (*b*) Production assistant with mechanical-engineering training and machine-shop experience, for job shop. $5200. Eastern Pa. W-7574.

Designers, Mechanical. (*a*) Designer, experienced in the design of rolling mills, especially tube mills, for the design of tube and pipe-mill equipment and supervising of detailing with prospect of handling complete tube mill as project engineer. $9600. (*b*) Designer, experienced in design of rolling mills, especially tube mills, for developing and designing of tube and pipe-mill machinery for the steel and nonferrous industry. $9600. Western Pa. W-7576.

Recent Graduate Mechanical Engineer, for work in auto-engine test laboratory evaluating performance characteristics of fuels and lubricants. Salary open. Pa. W-7587.

Plant Engineer, BSME or equivalent, ten years in plant engineering and maintenance of buildings and equipment; know process equipment, piping, wiring, steam generation, refrigeration, materials handling, packaging. Will be in complete charge of all plant-engineering work in branch plant of leading company in brewing industry. Responsible for annual capital expenditures, maintenance of buildings and equipment, operation of steam-generating plant, and refrigeration system. Emphasis on high maintenance and performance standards in bottling and shipping departments. Must be high-caliber man with strong administrative ability and able to advise plant manager on all technical matters of plant operation. $9000–$12,000. Employer will pay fee. Midwest or East. C-7232.

Transmission Design Engineer, graduate mechanical, ten years' experience in design of tractor-gear transmissions, semiautomatic, and automatic and torque-converter application. Must be capable of directing detail design of transmissions and their hydraulic-control components for a manufacturer of tractors. $12,000–$14,000. Employer will pay placement fee. Mich. C-7464.

Design Engineer, BSME or equivalent, ten years in design engineering work in food, beverage, or process industries. Must have substantial background in plant layout, equipment selection, and design of bottling, canning, packaging, and materials-handling systems. Will be design engineer in head office engineering department of leading multiplant company in brewing industry. Assignment will be primarily in fields of packaging and materials handling; it is expected applicant will become specialist in this category of engineering work and will provide technical assistance and guidance to personnel in the operating plants. Some travel. $8400–$10,000. Employer will pay placement fee. Ohio. C-7481.

Sales Engineer, engineering degree; three to four years' experience in heat-exchanger field; knowledge of heat-transfer equipment. Duties will include sales in Chicago office handling heat exchangers, large steam generators, and fabricated equipment. Company manufactures heat exchangers, boilers, vessels. Some travel, no more than a week at a time; car required. $7500–$10,000, plus expense account. Employer will negotiate placement fee. Chicago, Ill. C-7482.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after July 24, 1959, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

California

BROCKETT, WILLIAM A., Long Beach
GARRINGTON, GEORGE, San Diego
HOUSER, BRADFORD C., Pasadena
HSIA, WEI-LIN, San Francisco
MARTIN, RICHARD M., Berkeley
ROBERTS, CHARLES B., Los Angeles

Connecticut

•BIGELOW, CHARLES C., Manchester
•NEUENDORFFER, RICHARD, New London

Delaware

•BROOKS, EDWARD, Wilmington
IRWIN, FRANK, Wilmington
SCHAFFERS, WILHELMUS J., Newport

District of Columbia

ZAIDI, SYED J. H., Washington

•Transfer to Member or Affiliate.

Florida

MCWHORTER, ROBERT W., Pensacola

Idaho

•PRICE, THOMAS D., Idaho Falls

Illinois

BEAVER, DONALD V., Brookfield
•BOOTH, SYLVESTER F., Elgin
DANIELS, ARTHUR W., Geneva
MENKE, ELDON W., Homewood
PACKER, KENNETH F., Chicago
•SALTMAN, ELIAS, Rockford
WALDMAN, LEONARD F., JR., Melrose Park

Indiana

•WELSH, ERNEST J., Highland

Iowa

HOWARD, BARROIS A., JR., Davenport

Kentucky

SAXTON, DWAIN C., SR., Mayfield

Louisiana

WALTON, BILLY G., Shreveport

Maine

•WEIDHAAS, ERNEST R., Orono

Maryland

•BERTIER, THEODORE L., JR., Millersville
•GREESPON, JOSHUA E., Baltimore
JONES, EARL P., JR., Baltimore

Massachusetts

•BRADLEY, JOHN J., Boston
CORNELL, SIDNEY, Waltham
CROOKS, WILLIAM S., Attleboro
FELLOWS, JOHN H., Needham
GOLDMAN, EDWARD J., Braintree
HAQ, EHSAN U., Cambridge
HARVEY, EARLE M., Agawam
•LANG, RICHARD E., Concord
MAYOR, HARRY A., Fitchburg
•POLLARD, EDWARD V., Swampscott
ROSE, WILLIAM C., Holyoke
RYAN, RODNEY F., Springfield
UBERTO, HENRY F., Hingham

Michigan

ABBOTT, L. MERLE, Sanford
CAMPBELL, JOHN W., Detroit
•CHEN, YU, Allen Park
WESTRATE, MILLARD C., Jackson

Minnesota

•VINELLA, FRANK P., Minneapolis
WARREN, LEE E., Rochester

Mississippi

MCKASKEL, CARY L., Cleveland
WHEELER, KENNETH A., Pascagoula

Missouri

CANNON, ERNEST H., JR., Kansas City

New Jersey

ADAMS, ROBERT H., Somerville
BAKER, WILLIAM H., Chatham
•BELLI, VICTOR J., Passaic

●Bement, James A., Nutley
●Beveridge, Milton C., Maywood
Brkich, Alexander, Phillipsburg
●Fidelius, Walter R., Red Bank
Kise, Charles R., Trenton
Soojian, Vahn J., Pompton Lakes
Suhl, Charles A., Dover
Vasilakis, Michael E., Jersey City
●Weinberg, David L., Long Branch
●Wills, William, Dumont
●Zimmermann, David C., Mountainside

New Mexico

Duben, Joseph J., Los Alamos
●Gardner, Eugene K., Albuquerque

New York

Ames, James M., New York
●Anderson, Edward H., Irvington
Beer, Emanuel E., White Plains
Chen, Wilson S., Rochester
Collins, Jerome F., Westbury
●Collins, John L., Corning
Cordovi, Marcel A., New York
Costantino, Joseph J., Niagara Falls
Epping, Robert A., Schenectady
Franzel, Harvey L., New York
●Fulton, Robert P., Glen Head
Henderson, Paul, Corning
Hill, Herman R., Jr., Schenectady
Lari, Guide A., Bethpage
Melisz, John Michael, Buffalo
●Murray, Raymond E., New Hyde Park
Nickerson, Richard C., Schenectady
Noel, Hector F., Ballston Lake
Pellecchio, Vincent M., New York
Pichal, Henri T., Rochester
●Strock, Richard R., Levittown
Volpe, Hercules A., Poughkeepsie
Walters, Robert K., New York

Ohio

Adams, Richard L., Mansfield
Bart, Abraham, Cincinnati
Cheng, Kwo C., Columbus
●Craig, Dwight R., Mount Vernon
Davis, David R., Evendale
Ehrler, Robert F., Lancaster
●Jones, Charles E., Alliance
Kelly, Robert J., Wadsworth
Lea, Alfred L., Willoughby
Neesen, James C., Cincinnati
●Woodward, Robert A., Mount Vernon

Oklahoma

Lucenta, Frank C., Tulsa

Pennsylvania

Berndorff, Wilfried R., Willow Grove
Davids, Joseph, Havertown
Dill, Warren E., Philadelphia
Elias, John, Pittsburgh
Erickson, Edward E., Jr., Allentown
Heyn, Donald R., Pittsburgh
Kennedy, George R., Berwick
Kinnaird, John O., Oil City
Lang, Ronald, Quehanna
●Martin, Roger E., Shippingport
●Osgood, Charles F., Franklin
Sauter, Donald M., East Pittsburgh
Seel, Max, Lansdowne
Sreedharan, V. P., Pittsburgh
●Sutton, Harry G., Jr., Pittsburgh
Vail, George C., Philadelphia
Willsey, William B., Philadelphia

South Carolina

Johnson, James K., Clemson

Texas

Esphahanian, Nasser, Houston
●Ponsford, Emanuel E., Jr., El Paso
Rhoades, Frank L., Jr., Dallas

Utah

Dyck, Hubert I., Pleasant Grove

Virginia

Johnson, Roy E., Richmond
Malloy, John C., Jr., Arlington

Washington

Campana, Donald A., Bremerton
Jakub, Marlyn T., Richland

West Virginia

●Kelly, Frank C., Huntington

Wisconsin

Weissman, Harold M., Milwaukee

Foreign

Bahn, Michael, Hamilton, Ont., Canada
Beyer, Rudolf A., Olching vor Munchen, West Germany
Blok, Harmen, Rijswijk Z.H., Holland
Clark, Neil M., Farnborough, Hampshire, England
Dowson, Duncan, Leeds, England
Dubinsky, Alberto, Buenos Aires, República Argentina
Fagan, Eugene M., Port Credit, Ont., Canada
Gerlinger, Frederick P., Maracaibo, Venezuela
Kowadkar, Venkatesh Y., Sangli, Bombay State, India
LaVallière, Joseph A., Shawinigan, P.Q., Canada
Lee, Jae S., Chinhea, Korea
Mathew, Abraham, Calicut, Kerala, India
Min, Kun, UBARI, Kanbe, Rangoon, Burma
Thomann, George E.A., Oakville, Ont., Canada
Vega Del Barco, Antonio, Madrid, Spain

OBITUARIES

Oswald Cammann Brewster (1896–1958), consulting engineer, Litchfield, Conn., died Dec. 1, 1958. Born, Detroit, Mich., Feb. 25, 1896. Education, ME, Cornell University, 1920. Mem. ASME, 1947. Mr. Brewster had been a specialist in mechanical development work, particularly in connection with petroleum refining. He had, on a number of occasions, served as principal expert witness in litigation involving refinery technology. During World War II, Mr. Brewster was petroleum consultant to the Board of Economic Welfare and served as chief of its Policy Division. In 1942 with the The M. W. Kellogg Co., he did work on the atomic bomb, developing pumps for use in the diffusion process. He had been in independent consulting practice since 1945. He held numerous patents and was the author of several papers. He was a registered professional engineer in the State of Connecticut. Member of Tau Beta Pi.

Frode Siegfred Fernstrom (1896–1959), assistant manager, management service department, Ernst & Ernst, Philadelphia, Pa., died Feb. 19, 1959. Born, Brooklyn, N. Y., May 5, 1896. Parents, George H. K. and Sara (Jensen) Fernstrom. Education, Pratt Institute and Brooklyn Polytechnic Institute. Married Vilma R. Ebbesen, 1921. Assoc. Mem. ASME, 1917; Mem. ASME, 1935. Survived by his widow; and a daughter, Mrs. Carl Henry Delacato.

Henry William Foulds (1891–1959), chairman of the board, Pfaudler Permutit Inc., New York, N. Y., died April 4, 1959. Born, Edinburgh, Scotland, Jan. 10, 1891. Parents, Henry T. and Marie (Pillans) Foulds. Education, BS(ChE), University of Pennsylvania, 1914. Married Rose Huntington, 1922; four children, Henry W., Jr., Ralph H., Robert S., and Jacqueline Foulds. Mem. ASME, 1943. Mr. Foulds joined the Permutit Co. in 1935.

Norman Frederick Hindle (1902–1959), head of mechanical engineering department, University of Idaho, Moscow, Idaho, died March, 1959. Born, Fort Wayne, Ind., April 9, 1902. Parents, Edmund William and Caroline Dorethea (Kley) Hindle. Education, BS(ChE), Purdue University, 1925; MetE, 1949; BS(ME), University of Idaho, 1949. Married Jeanette B. Merillat, 1925; one daughter, Barbara Jane Hindle Ellis. Mem. ASME, 1944. Professor Hindle joined the faculty at Idaho in 1947. He was the author of numerous articles on the subject of metal casting and foundry operations. He edited three editions of the "Cast Metals Handbook," two editions of "Alloy Cast Irons," and was editor of *American Foundryman Magazine* and the *Transactions of the American Foundrymen's Association*. Professor Hindle served the Society on the Papers Committee of the Management Division and was a member of a Regional Administrative Committee. He received the ASME 75th Anniversary Medal. He was a registered professional engineer in the State of Illinois. His memberships in other societies included ASEE, ASM, AFS, Sigma Xi, and Theta Tau.

Donald Theodore Metz (1907–1959), assistant to sales manager, Byron Jackson Pumps, Inc., Los Angeles, Calif., died March 30, 1959. Born, Independence Townsite, Washington County, Ohio, Jan. 10, 1907. Education, night school study, five years. Mem. ASME, 1944. Mr. Metz had been with Byron Jackson Pumps since 1927.

John Winslow Nickerson (1887–1959), consulting management engineer, Niantic, Conn., died March 23, 1959. Born, Boston, Mass., May 7, 1887. Parents, Winslow and Ella Frances (Robbins) Nickerson. Education, BS, Massachusetts Institute of Technology, 1909. Married Alice Robinson, 1913. Assoc. Mem. ASME, 1911; Mem. ASME, 1920; Fellow ASME, 1954. For over 25 years he was with Cheney Brothers, Manchester, Conn., serving in the beginning under the direction of Henry L. Gantt, a pioneer in scientific management. He was later in charge of industrial engineering, industrial relations, technical research, and mill management. From 1942 to 1945 he was director of management, Consultant Division of the War Production Board, Washington, D.C. He was responsible for making industrial engineering and labor relations advice available to all American industry as well as to the military establishments, the War Labor Board, and other agencies. Mr. Nickerson represented textile management on the Textile Work Assignment Board established by the President of the United States, following the general textile strike in September, 1934. He was chairman of the Advisory Group on European Productivity for the Mutual Secruity Agency and consultant to the director of the Productivity and Technical Assistance of MSA. He was the recipient of the first Industrial Incentive Award given by SAM in 1950. Mr. Nickerson was the author of many papers on management subjects. In 1931 he was a member of the ASME Management Division Executive Committee. Survived by his widow.

Gustav Edwin Olsen (1897–1958), executive vice-president, Sales and Engineering Division, Fitzgibbons Boiler Co., New York, N. Y., died Dec. 23, 1958. Born, Rockway Beach, L. I., Jan. 1, 1897. Parents, Gustav and Mathilde Olsen. Education, ME, Cooper Union, 1918; and Brooklyn Polytechnic Institute, 1921. Married Miss Miller, 1931; two sons, Robert M. and Richard K. Olsen. Assoc. Mem. ASME, 1920; Mem. ASME, 1955. A specialist in boiler design, construction, testing, and operation, Mr. Olsen had been with the Fitzgibbons firm since 1913. During World War I he served in the U. S. Navy. He was the author of many articles published in trade magazines. He was a member also of ASHVE and NSPE.

James Joseph Rush (1893–1959), retired, assistant engineer, mechanical designer, Pioneer Service and Engineering Co., Chicago, Ill., died April, 1959, in Providence, R. I. Born, McKeesport, Pa., Jan. 3, 1893. Education, attended Northeastern College; BS, Tri-State College, 1924; ME, 1929. Mem. ASME, 1948. Mr. Rush had been with Pioneer since 1941. He was a specialist in the field of public-utility power-plant design. He was a registered professional engineer in the States of Illinois and Ohio. Survived by his widow.

Herman John Schrader (1901–1959), whose death recently was made known to the Society, had been research professor, department of theoretical and applied mechanics, University of Illinois, Urbana, Ill. Born, Lafayette, Ind., Sept. 11, 1901. Education, BS(ME), Purdue University, 1923; MS, University of Illinois, 1937. Mem. ASME, 1939. Professor Schrader who had been on the faculty at Illinois since 1925 was a specialist in the field of railway mechanical engineering. He was the author of numerous publications on the subject. He was a member also of SPEE and Sigma Xi.

Andrew Gordon Simpkins (1903–1959), supervising design engineer, Electro-Metallurgical Co., Division of Union Carbide Corp., Niagara Falls, N. Y., died March 6, 1959. Born, Niagara Falls, N. Y., Aug. 9, 1903. Education, attended University of Michigan, 1927–1929. Married Frances Burwell. Mem. ASME, 1958. Mr. Simpkins had been with the Electro-Metallurgical Co. since 1930. Survived by his widow.

Norman Leslie Smith (1891–1959), engineer in charge of Foundry Equipment Div., Link-Belt Co., Philadelphia, Pa., died January, 1959. Born, Philadelphia, Pa., May 16, 1891. Parents, Alfred P. and Mary J. Smith. Education, ICS (Arch). Married Edith E. Clarke, 1917. Assoc. Mem. ASME, 1927; Mem. ASME, 1935. Mr. Smith had been with Link-Belt since 1917.

Robert William Smith (1875–1958), plant engineer, Wyandotte Chemical Corp., Wayndotte, Mich., died Dec. 20, 1958. Born, Detroit, Mich., May, 1875. Education, Detroit public schools and high school. Mem. ASME, 1914. Survived by his widow.

Burnett Forrest Treat (1898–1959), associate professor of mechanical engineering, The University of Texas, Austin, Texas, died March 13, 1959. Born, Kansas City, Kans., March 2, 1898. Education, BS(ME), University of Kansas, 1923. Mem. ASME, 1947. Professor Treat had been on the faculty at the University of Texas since 1946. Prior to that time he was at the Engineering Experiment Station, U. S. Navy, Annapolis, Md., 1927–1943; and with the Bureau of Ships, 1943–1946. During World War I, he served as a lieutenant in the U. S. Army. He was author or co-author of several technical papers and a book on engineering thermodynamics. He was a member also of ASEE, NSPE, Tau Beta Pi, Pi Tau Sigma, and Sigma Tau.

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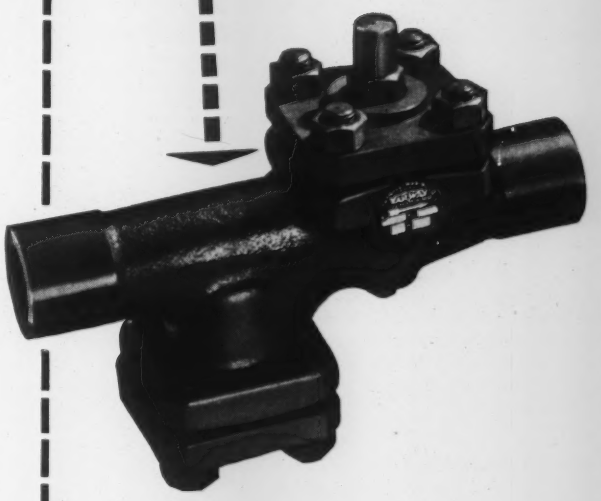

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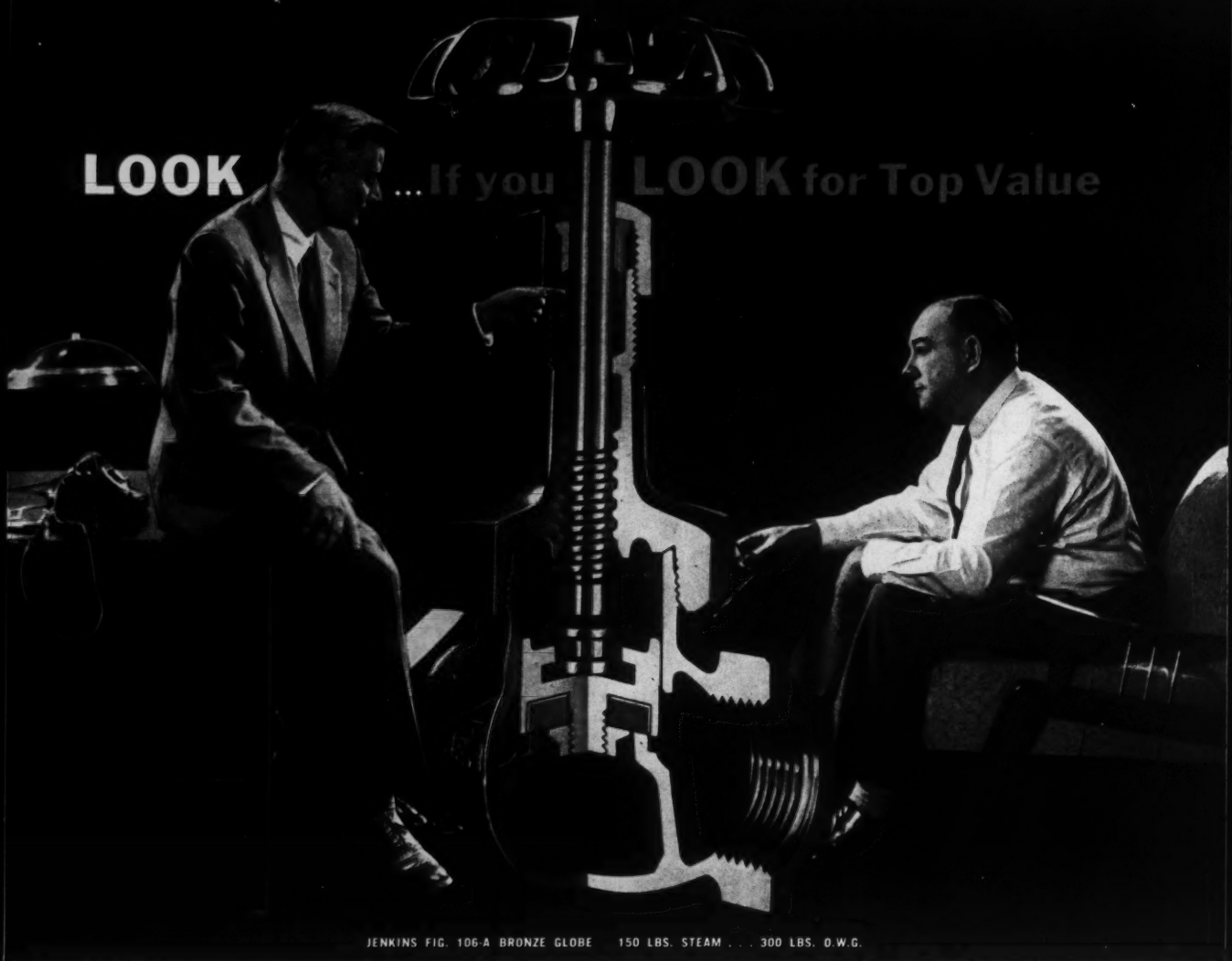

JENKINS FIG. 106-A BRONZE GLOBE 150 LBS. STEAM . . . 300 LBS. O.W.G.

in Disc Equipped Bronze Valves

LOOK at that Wheel — Tough malleable iron. Design unequalled for cool, sure grip.

LOOK at the Index Plate — Has Fig. No. etched in green background. Held by wheel nut which is secured by rolled-over spindle end.

LOOK at that Spindle — Made of high tensile bronze. See how much heavier it is . . . how many more deeply cut threads engage bonnet. And, the crowned head that reduces friction on disc holder. Sure, it costs more to make a spindle this way. But it reduces wear, preserves packing, means easier operation.

LOOK at the Packing Nut and Gland—Note the heavy and deep bronze hex. And, that bronze gland designed to compress packing toward spindle.

LOOK at that Packing Box — Its depth equals 1½ times spindle diameter. More packing space means less repacking. An asbestos, lubricated and graphited packing is used.

LOOK at that Bonnet — One-piece, screw-over design with big hex surfaces is easy to remove. Take an extra look at the bevel joint between bonnet and body, serving as an internal brace against the crushing effect of the bonnet assembly. Millions of Fig. 106-A in use for years prove this unique design licks distortion and springing.

LOOK at the Disc Holder — It's the Slip-on Stay-on type originated by Jenkins. Correct protective depth prevents flaking or cracking of disc.

LOOK at the Disc — Easily renewed without removing valve from line. Made of compositions to suit various services . . . and **made by Jenkins,** the only maker of both valves and discs.

LOOK at that Body — Just compare wall thickness of this high tensile bronze body with any other valve. The factor of safety is many times higher than rating requires. See the curved diaphragm to protect seat from distortion by pipe strain. Note that the raised seat is higher to permit more reseating operations . . . and wider, so it won't cut into disc. Pipe threads are full length and clean cut.

LOOK at this . . . for Throttling

—Just replace the standard disc nut with this Throttling Nut and a Fig. 106-A becomes well-suited to throttling service. This unique nut reduces the effects of wire drawing and its long legs restrict flow for accurate control. Many plants take advantage of this versatile valve to reduce valve and parts inventory.

THE FIRST renewable composition disc valve was a Jenkins Valve, originated nearly a century ago. Compare today's Fig. 106-A Bronze Globe with any other. See why so many valve users agree that a *Jenkins* is still the FIRST for top value. For descriptive folder No. 189-B on the full line of Jenkins Bronze Globe, Angle and Check Valves write to Jenkins Bros., 100 Park Avenue, New York 17.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES

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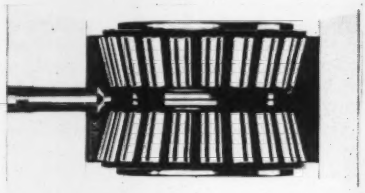


Double Cup Bearings

Timken Roller Bearing Co. has introduced a new line of Pin type double cup bearings.

The bearings have been developed primarily for applications where the bearings are used with loose cup fits, unclamped in floating positions and where experience has indicated that a cup locking device is desirable.

A hollow pin located in the housing fits into the large counter sunk hole in the cup OD. While the pin prevents the cup from turning in the housing, it does not restrict axial float, normally required as a result of shaft or housing expansion, the firm reports. This design is said to facilitate the highly desirable feature of insuring positive bearing lubrication by introducing the lubricant through the hollow pin direct to the center of the bearing.

The Pin type double cup bearings are designed to be dimensionally interchangeable with conventional Timken double cup bearings.

Constant Level Oiler

Oil-Rite Corp. has announced a new constant level oiler, Style CS, designed to automatically maintain the oil in a bearing at a constant level and incorporating a sight in the base of the oiler.

The oiler is furnished with $\frac{1}{2}$ in. pipe thread on the side and bottom outlet. Either outlet can be used. The other may serve as a drain. They can be filled through a top filler cap.

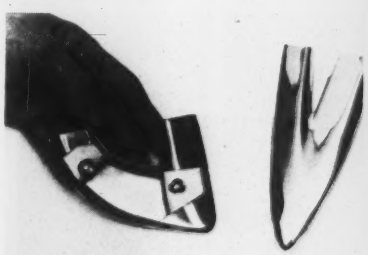
An air intake of $\frac{1}{8}$ in. female pipe thread allows an air filter to be readily inserted. The air intake can also be piped into the top of a bearing housing to equalize any pressure differential. Surge extension adaptors can be screwed into the air intake to increase the surge level of the oiler.

Vibration Test Fixture

A new auxiliary vibration test fixture has been announced by MB Mfg. Co., Div. of Textron Inc.

Designated Tri-Mode, the fixture is available in two sizes to accommodate the firm's Models C25H and C10 vibration exciters. The units are of welded tubular steel construction.

The larger unit, Model TM25, permits vibration testing of specimens up to 66 in. long and 44 in. wide. The firm says specimen height is not restricted by any structural part of the test fixture. Limited environmental tests can be conducted by mounting a suitable hot-cold or altitude chamber on the test fixture.



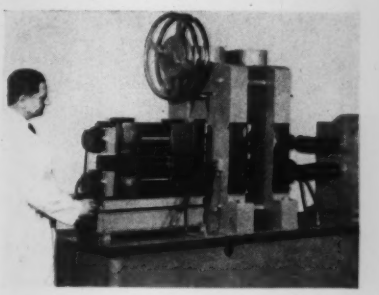
Stainless Fastenings

A new method of welding stainless steel fasteners to stainless steel stampings without leaving any weld marks on the pieces has been developed by Primeweld Corp.

The firm says the secret of the patented process is in the transformer. Engineers report that they use low voltage and high amperage in welding the stainless steel parts, which were supplied by Allegheny Ludlum Steel Corp. The welder sends enough wallop through the pieces to quickly join the metals, but not enough to distort or discolor the metal.

Besides making for a 100 per cent stainless steel moulding, which will not corrode, the method is claimed to offer other advantages. The company says automobile manufacturers formerly had to go through eleven separate operations to make and attach a piece of moulding to their products. Primewelding has cut this to three separate operations, and gives a stronger product.

In addition, the wide flange usually on the moulding can be eliminated, thus saving on material.



Combination Rolling Mill

The development of a heavy-duty, high-precision 2-high/4-high combination rolling mill for application in nuclear metals production and research work has been announced by Loma Machine Mfg. Co.

The firm says the outstanding feature of the new machine is its complete enclosure in a glovebox to allow the processing of alpha-active, pyrophoric materials, such as plutonium fuel elements.

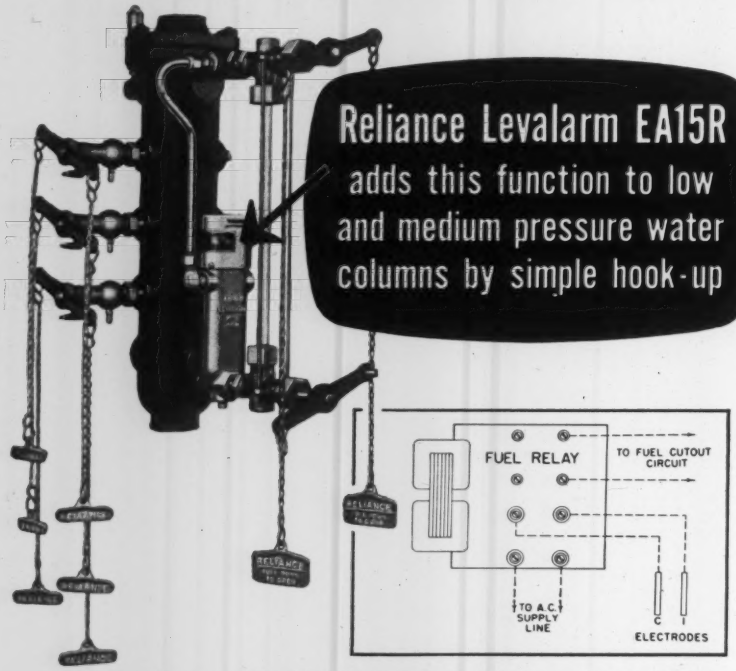
To facilitate remote control operation within the glovebox enclosure, the mill is equipped with a semi-automatic roll changing device comprising a sliding way, a quick-disconnect screwdown, a universal spindle support and pull-off oil lubrication lines. The entire roll assembly may be moved into or out of the mill by turning a hand-wheel.

The machine is operated in either a 6 x 8 in. 2-high set-up of a $1\frac{1}{2}$ in. & 6 x 8 in. 4-high set-up. The 2-high arrangement is used for either hot or cold breakdown rolling of plate and sheet, and grooved rolls are also available to process rounds, squares, and other shapes. In the 4-high set-up strip is cold finish rolled to gages as thin as 0.001 in. maintaining a 5 per cent tolerance.

The mill is furnished with high-strength steel housings, twin-handwheel wormdrive screwdowns, universal joint spindles, herringbone gearing, and a 15 hp four-speed gear-shift drive. The rolls are made of forged alloy steel and are hardened to 100 Shore Scleroscope. The roll necks are mounted in super-precision needle roller bearings having a total separating force capacity of 175,000 lb. The bearings are continuously lubricated by an oil circulating system.

Special cartridge heating elements are mounted in the hot rolls to prevent undue chilling of the materials being hot worked. The heating elements are fed with current through slip rings and brushes mounted at the outboard side of the mill.

Install a fast-acting, positive fuel cut-out control at low cost



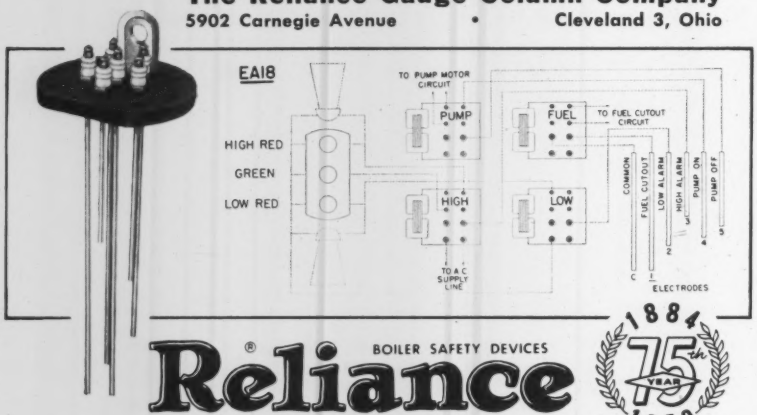
Two electrodes extend into boiler water in the Levalarm chamber. Water surrounding them completes a closed circuit carrying special current supply from a transformer. When water level drops below the electrodes, the relay circuit to the solenoid-operated fuel valve is broken. Action is immediate. An auxiliary alarm can be actuated at the same time. This Levalarm may be installed on any water column having gage centers not less than 12½"; maximum 450 psi. Very easy to install . . . Another model is designed for pressures to 900 psi.

Up to FIVE functions possible with other Levalarms

Broad protection for your boiler's safety can be realized through multiple-electrode Levalarm models that install in the water column cap. Model EA18 has enough electrodes to provide fuel cut-out, low and high water alarms, and start and stop feed pump. To comply with insurance company rulings requiring dual fuel cut-out facilities, an extra electrode can be added to the Levalarm. Thus no additional piping needed.

It will pay you to get details on Reliance Levalarms. Write for Bulletin D2 or contact nearest Reliance Representative.

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio



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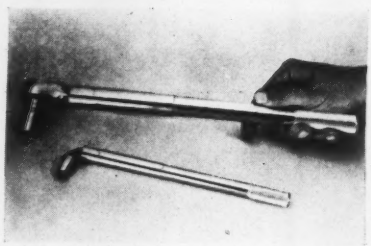

Snap Torque Wrenches

A new line of adjustable snap torque wrenches, incorporating features said not to be heretofore available on tools of this type, has been introduced by the Skidmore Engineering Co.

The line includes both plain square drive and ratcheting square drive types. A dual scale is incorporated into each wrench so that either inch-pound or foot-pound settings can be made without conversion of figures.

After the desired torque is preset, and the wrench placed into service, a distinct snap (which is both heard and felt), signals when the preset torque has been reached, the firm reports.

The new line includes six models: the smallest size has a range of 20 to 240 in-lb, while the largest has a range of 200 to 600 ft-lb.

Automatic Engine Controls

Synchro-Start Products, Inc. announces a new series of controls encased in steel, dust proof cabinets and featuring overload breakers and plug-in relays.

In closing the cover of the cabinet, a cushion pressure is brought into play that positively locks the relays in their sockets so they cannot possibly be vibrated loose, the firm reports. An engine, equipped with one of these automatic control sets, can be started or stopped from remote pilot devices such as pressure switches, float switches, power failure relays, and are completely automatic in operation.

Electric Cranes

Two new mobile electric cranes, which can set their own outriggers and be ready to lift capacity loads within 30 sec, have been announced by R. G. LeTourneau, Inc.

Known as the Series R-30 and the Series R-45 cranes, they have capacities of 30 and 45 tons respectively. All operating functions of both are electrically powered.

Individually operated, electric-powered outriggers from a level lifting platform on varied terrain, and are controlled from within the operator's cab.

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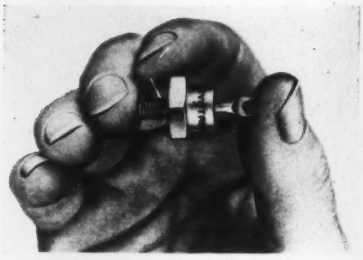


Silicon Rectifiers

The availability of new, smaller Silicon a-c to d-c power rectifiers is announced by Syntron Co.

The style-30 rectifiers, weighing only $\frac{1}{2}$ oz, are more compact for wider latitude in equipment design and for easier installation in smaller areas, the firm states. The complete diode, with an $\frac{11}{16}$-in. hex stud base, has maximum height of $1\frac{7}{16}$ in.

The diodes are said to be a highly efficient rectification medium with very good electrical and mechanical characteristics.

They are rated at 10 amp average at 150 C ambient, and are available with peak inverse voltages ranging from 50 to 400 v, in 50-v steps. Their outer case is nickel plated.

Teflon Bearings

Radial Bearing Corp. announces a new series of spherical bearings, rod end bearings, and bushings using Teflon TFE-fluorocarbon fiber.

Projected use of the units includes the fields of aircraft, construction equipment, oil field drilling, food processing, agriculture, and textile machinery.

The company says the bearings utilize the fiber's low coefficient of friction—from 0.01 to 0.04, depending upon the particular service—to offer a combination of properties excellently suited to low surface speeds, high unit loads, or applications subject to high dynamic loading.

Manual Engine Control

A 21-lb control unit has been qualified by its manufacturer, Aero Supply Mfg. Co. for 100,000 cycles of endurance.

The control, No. 16-1839-000, houses all hand-operated levers for throttle, mixture, propeller pitch, flaps, arresting hook, gust lock, and catapult grip.

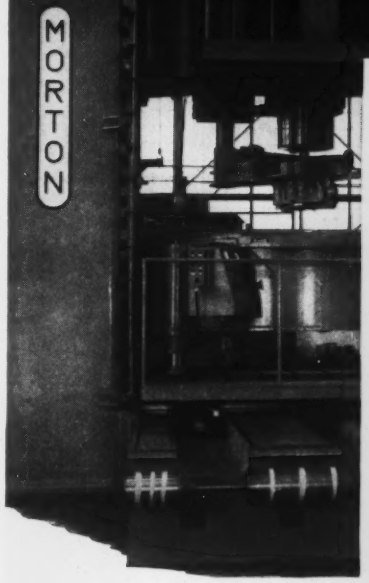
To prevent lever creep, both the throttle lever and propeller pitch lever have individual friction adjustments. Individual friction control may be incorporated into any element depending upon specific aircraft requirements, the company states.

You can solve many problems better and at lower cost with DIAMOND Roller Chain

another **BIG JOB** *calls for dependable*

DIAMOND
ROLLER CHAIN

Four 2" pitch DIAMOND Roller Chains insure smooth, dependable operation in this counterweight application.



◀This 40-foot high, 525,000-pound Vertical Boring and Turning Machine built by Morton Manufacturing Company of Muskegon Heights, Michigan, uses DIAMOND Roller Chains on the counter-weights.

DIAMOND Roller Chain assures long trouble-free life, efficient service and low-cost maintenance in every type of roller chain application.

When you need chain, specify DIAMOND. Write now for catalog containing complete information on DIAMOND Roller Chains and Sprockets. Engineering service is available.

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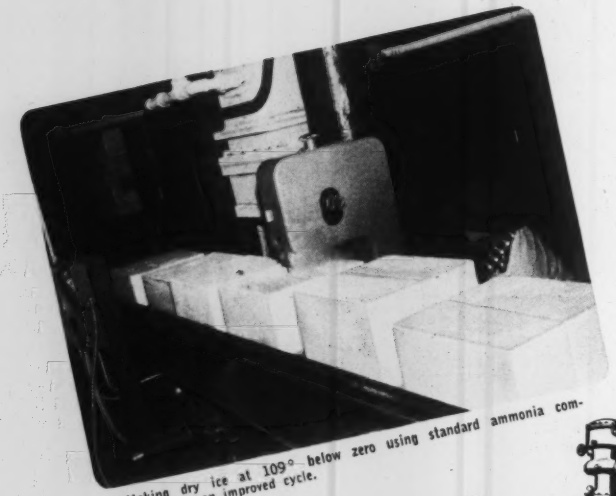
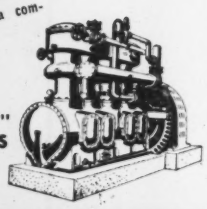
DIAMOND ROLLER CHAINS



Making dry ice at 109° below zero using standard ammonia compressors in an improved cycle.

"HEAVY DUTY" COMPRESSORS



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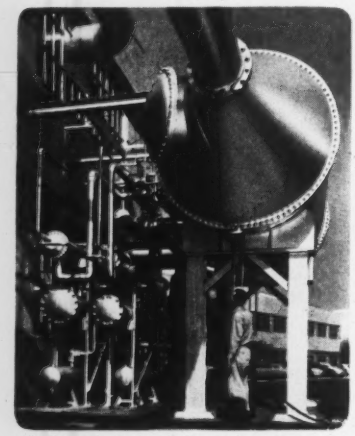
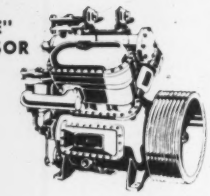
to solve your most difficult cooling problems.

If you need any type of industrial or commercial cooling—for quick freezing, cold storage, ice making, humidity control, low temperatures, condensing, air conditioning, or any process work—contact the nearest Frick Branch or Distributor for recommendations and estimates.



Cooling air under pressure for supersonic speed tests.

"ECLIPSE" COMPRESSOR



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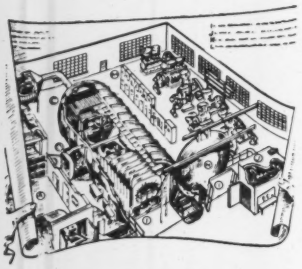
WAYNESBORO, PENNA., U.S.A.

Test laboratory work for temperatures down to 140° below zero.



All-weather Laboratory built for U. S. Army. Uses 3-Stage compressors, mantains Arctic, tropic and stratospheric condititions.

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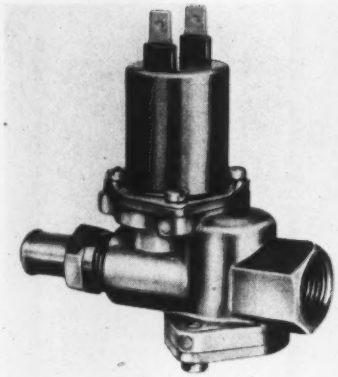

Solenoid Valve

A new specially-designed solenoid valve which is being used successfully in coffee and hot chocolate vending machines, as well as automatic dish washers and water softeners has been marketed by the Detroit Controls Div.

The new S-25 valve features constant water flow and accurate delivery regardless of varying supply pressures. The unit has positive opening and closing at pressures from $2^1/_2$ to 200 psi, with flow capacities from $^1/_4$ to 6 gpm, for temperatures up to 180 F.

Pick-up Trolley

A new trolley type high-current pick-up device with capacity for handling up to 1200 amp is now available from Anchor Steel & Conveyor Co.

The new trolley travels on a bus bar (rail) and transmits high-current electrical power while in motion or at rest. Basically designed for welding and plating systems, the pick-up is said to be suitable for any high-current application. It is guided in all positions by nylon rollers, which require no lubrication.

The roller mounting permits it to be applied to curved as well as straight bus bar sections, the firm states. It can be used with either vertical or horizontal bus bars. Only a small amount of clearance is required by the unit when in motion.

Hand Spring Coiler

Carlson Co. has introduced a hand operated spring coiler designed for use with samples and small production.

The firm says adjustments are easily set to provide any desired pitch, automatic squaring of end coils, left or right hand winding and an exact number of coils desired. Production is 300 to 400 precision springs exactly alike per hour, and capacity is wire diameters from .004 in. to .063 in., spring diameters up to $1^1/_2$ in. lengths up to 5 in.

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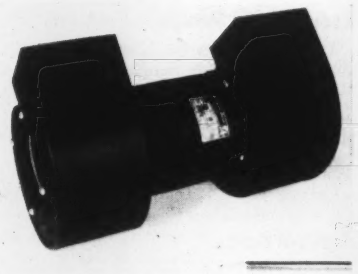

Double Blower

Electro Products Div., Western Gear Corp., announces the addition of a new double blower to their standard line. This double blower is powered by a 115 volt a-c single phase 60 cycle motor.

It has an output of 100 cfm (minimum) of free air per blower at 3300 rpm. The blower is said to have an exceptional low noise level. The over-all length of the double blower is approximately 8 in. Its greatest diameter is slightly over 5 in.

Ball Joint Design

A new, recently patented ball joint design concept by Superior Ball Joint Corp. is said by the maker to increase life by a factor of 2 or more compared to conventional designs, while reducing the number of parts in the assembly.

The company, which offers a line of sizes from No. 10-32 through $^3/_4$–16, states that its new SP series provides increased life and shock resistance because of a redesigned ball which departs from the conventional spherical shape and which features a shorter heavier neck.

Greater strength and better wear characteristics are said to be obtained without sacrifice of angular deflection in any direction. Movement is free at any point in a minimum conical angle of 30 deg regardless of the plane of deflection.

The female part of the joint has been completely overhauled in the interest of reducing required number of parts and their costs. In its entirety, this assembly consists of two parts, the joint body and a spring steel retaining sleeve. Spring loading mechanisms, end screws and cotter pins are eliminated, thus providing an overall assembly of simpler construction, and more foolproof operation.

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APCO PUMPS

- PROVEN DEPENDABILITY
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- SERVICE FLEXIBILITY
- PRESSURES TO 400 P.S.I.
- CAPACITIES TO 150 G.P.M.

Ruggedness of construction and simplicity of design of APCO turbine type pumps combine to provide longer life, high efficiency, and minimized down time. This means more for your "pump operating dollar." With APCO *steep impeller* characteristics there is little capacity change under fluctuating head conditions. Select from the "1001" types, sizes, and capacities of AURORA pumps to obtain *the one* specifically designed to fit your needs.

APCO turbine type pumps are most frequently used for: Boiler Feed, Condensate Return, Fresh Water Service, Brine Service, Ice Water Circulation, Filter Service, LPG Service, Transfer Service, Caustic Liquid Handling, Sprinkler Service, Spraying Service, Water Treatment, Booster Service, and High Temperature Service.

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NEW VOUGHT PROJECTS OFFER CAREER APPEAL TO CREATIVE MEN

exploratory work in wide variety on new metals, methods and weapons

Chance Vought is advancing on many fronts. In *Astronautics* there is development of the 4-stage "Scout" research rocket for NASA. In *Antisubmarine Warfare*, detection and classification studies for the Navy. In *Advanced Weapons*, hypersonic systems are in development. *Electronics* for weapons – and for advanced control systems – are being developed by Vought. The company's Range System Division is managing key missile ranges. These activities have prompted exploratory work in the following areas:

Structures (Supersonic and Hypersonic)
Heat transfer, thermal stress and deflection analysis, and stress analysis using high-speed computers.

Manufacturing R & D
Welding and brazing of super alloys and exotics; advanced forming and cutting studies; prediction of metal fabricability.

Industrial Engineering
Project estimating, work sampling, line load and balance, and packaging and installation of new procedures.

Antisubmarine Warfare
Studies of detection and classification techniques involving Acoustics, Geomagnetism, Geophysics, Electromagnetics, Electrochemistry, Math.

Engineering Planning
Man-hour and budget forecasting, and project planning and scheduling.

Product Design
Automatic escape devices, atmospherically sound cockpits and advanced instrument displays for space pilot, crew.

Flight Test Instrumentation
R & D in new techniques for electronic gathering and reducing of flight test data.

Aerodynamics
Wind tunnel and model work employing Vought's 3,800-mph high-speed wind tunnel and new "high-temperature" laboratory.

Qualified applicants are invited to write:

J. W. Larson
Ass't. Chief Engineer, Administrative Dept. T-6

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CHANCE VOUGHT DALLAS, TEXAS

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Radial Piston Pumps

Texas Hydraulics, Inc. is now offering variable volume radial piston pumps to industry.

Available are pumps, with a complete line of controls, in 18, 50, and 200 gpm sizes, all rated at 3000 psi and capable of 5000 psi maximum pressure.

Package Boiler

A new type of package boiler, whose weight and volume are only one-sixth that of an equivalent conventional unit, is now available from Turb-O-Heat, Inc. It can deliver continuous quantities of 100-psig steam within 15 sec, starting with cold tap water.

The firm says design of the generator is based on an entirely new concept, namely a fin-and-tube heat exchanger section rotating at high speed (3600 rpm) within the casing. The centrifugal force on the fluid in the tubes promotes a rapid flow through the tubes, resulting in a rate of heat transfer of better than 300,000 Btu per hour.

The company explains that centrifugal force acts on the varying density of the liquid, to cause vapor disengagement at the liquid surface rather than at the tube wall. Scale build-up and fouling of tubes are thus prevented. The generator acts as a pump on both the liquid in the tube and the hot gases in the shell. Exhaust gas speeds are much higher than usual, so that a 4-in. pipe will suffice where a 10-in. vent would normally be required.

Power Transmission Belt

Manhattan Rubber Div., Raybestos Manhattan, Inc., reports the introduction of a new Poly-V belt, the Poly-V J. The belt is especially designed for high-speed, small-pulley, power transmission applications.

The firm says the new belt is thin and very flexible, and retains all the advantages of standard Poly-V drives. It will operate over sheaves as small as 0.8 in. pitch diameter. Pitch lengths range from 8 to 98 in. It is designed to deliver power with substantially less belt width than would be required using a standard belt drive.

This is accomplished through application of a single endless rubber belt with a series of parallel V-ribs molded lengthwise around the inside circumference. Sheave grooves are designed to mate with the belt ribs, and the load is evenly distributed across the full width of the drive member.

The company reports that the new product has been successfully tested for use in such applications as home and workshop appliances, office equipment, attic fans, chain saws, pumps, garden and farm power implements, light industrial equipment, and power tools.

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Miniaturized Lubricating System

A new miniaturized injector system for automatic lubrication of production machinery has been introduced by Lincoln Engrg. Co., Div. of McNeil Machine & Engrg. Co.

The firm says the system, called Micro-Measure, pre-measures and injects fluid lubricants to millionths of an ounce in automatic cycles as often as every minute. An automatically controlled, air-operated pump supplies refinery-pure lubricant to small, economical injectors with micro-meter adjustment—at a predetermined rate, in quantities as small as $^1/_{135}$ of a drop.

The system is said to maintain a constant, uniform oil film on all bearing surfaces with no overflow and no dripping.

Proportioning Pump

A new, electrically driven, positive displacement chemical proportioning pump has been introduced by B-I-F Industries, Inc.

The unit, Proportioneers Model 1210 Chem-O-Feeder, features a corrosion-resistant transparent plastic head, Hypalon diaphragm and check valves, and a straight-through flow design.

According to the company, the unit accurately and uniformly porportions chemical solutions, acids and alkalies to process water in industry. It is said to be ideal for the water treatment field, for industry, swimming pools, chemical plants, municipalities.

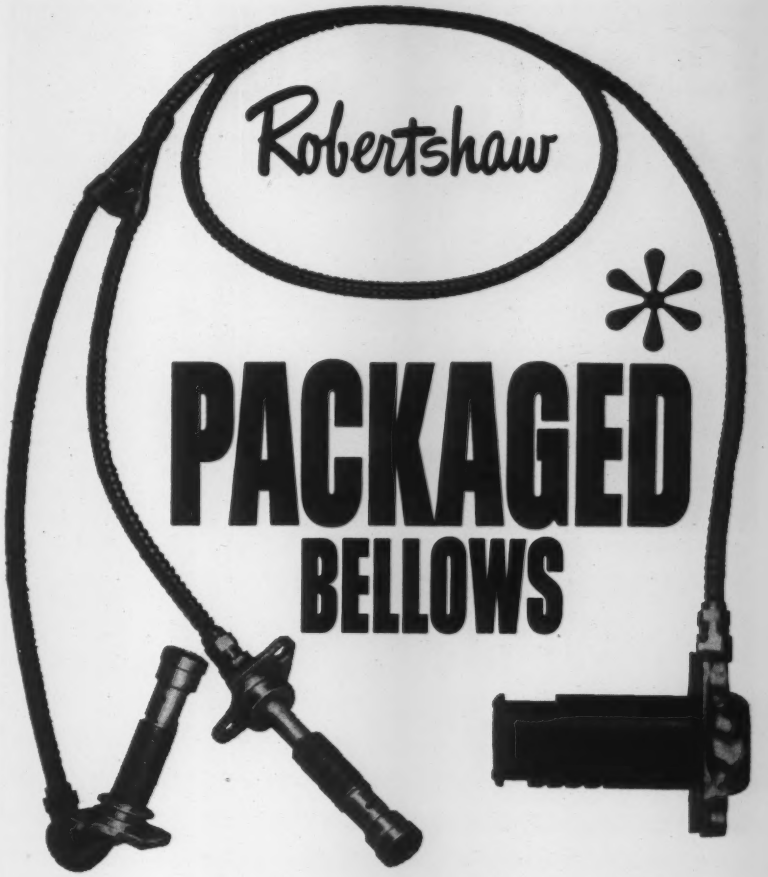
The new pump is available in three models, simplex, duplex and triplex, for adjustable, wide-range porportioning up to 12, 24 and 36 gph with discharge pressures up to 125 psi.

Corrosion-Resistant Fittings

A new line of fittings has been introduced by Amercoat Corp. for its reinforced plastic pipe for industrial plants and factories.

The pipe, called Bondstrand, has been tested in fresh, salt, and waste water, sewage, oils, solvents, foods, beverages, gases, and other corrosive solutions, the firm reports. It may be used for ducts, conduit and handrails in difficult plant environments. The company says the exterior of the epoxy-and-fiberglass pipe withstands fumes, moisture, spray, spillage, water immersion, acid, and alkaline soils and stray currents.

The new fittings include 90 and 45 deg elbows, tees, couplings, and other fittings for either threaded-end or plain-end pipe. Fittings for the latter are connected by a patented locking wedge feature. Ductile iron flanges with the locking wedge feature are also in stock. These are designed so the piped contents cannot contact the iron. A second type of flange now being perfected will be made entirely of the Bondstrand material.



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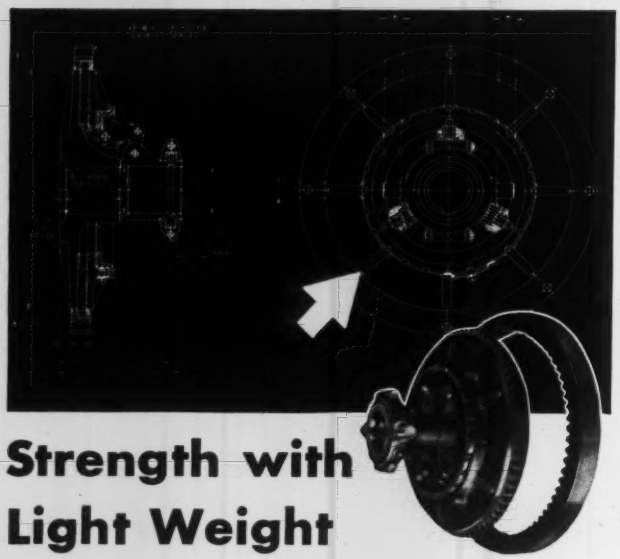
ROCKFORD



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Ribbed construction, in ROCKFORD HE Over-Center CLUTCHES, provides strength, without undue weight, to the clutch body and pressure plate. Driving pressure is applied toward the outside of the facing to assure that ROCKFORD CLUTCHES will continue to pull their full rated load during their long service life—particularly in power take-off applications. The load is carried by teeth on the outside diameter of the facing member. While your power transmission control projects still are in the planning stage, it will pay you to consider how this ROCKFORD CLUTCH will provide added strength with less weight.

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CLUTCHES

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Chemical Metering Pump

For metering clear and corrosive liquids to chemical processes, Milton Roy Co. has announced its new Model CM chemical metering control volume pump.

The company says the unit delivers maximum capacities to 28 gph in simplex designs and double that gallonage in duplex designs. It is constructed to handle pressures to 1100 psi.

Screwed gland packing is designed to provide application flexibility and a choice of materials of construction. Stroke length, which is $1\frac{1}{4}$ in. at maximum is adjustable from 0 to 100 per cent of maximum, thereby changing the capacity for the full range of the pump. Capacity is regulated by standard manual T-slot adjustment of the plunger stroke while the pump is stopped.

The unit uses a standard drive of $\frac{1}{2}$-hp constant speed electric motor through a right-angle gear reducer. The motor is an open, drip-proof, single-phase, 115 v, 60 cycle unit.

Wear Strip Rectangles

Twenty-three new sizes of extruded rectangles are being produced by Ampco Metal, Inc. to supplement the firm's line of wear strip and wear plate material.

The new rectangles are extruded from continu-cast billets of Metal Grade 21, a hard alloy recommended by the firm for severe metal-to-metal wear applications, extremely heavy loads and abnormally high abrasive conditions.

Average physical properties of the Grade 21 extruded rectangles are 110,000 psi; ultimate tensile strength, 68,000 psi; yield strength, 50,000 psi; elastic limit in compression and 310 Brinell hardness (3000 kg load).

Alloy Tubing

Small tubing of A-286, an austenitic alloy of approximately 55 per cent iron, 25 per cent nickel and 15 per cent chromium, has been successfully cold drawn by Superior Tube Co. and is now being offered commercially for high temperature applications.

A-286 was developed by Allegheny-Ludlum Steel Corp. primarily for applications where high strength is required at temperatures from 1000 to 1300 F. The firm says its oxidation resistance is as good as that of AISI Type 310 stainless steel at temperatures up to 1800 F. On engine tests lasting over 500 hr up to 1300 F, it shows excellent corrosion resistance against all atmospheres encountered in gas turbine service, the company reports.

Tubing made from A-286 is expected to have wide use as gas turbine structural and fuel-line parts and as aircraft mechanical and hydraulic tubing, and in industrial applications where strength and oxidation resistance at high temperatures are required.

KEEP INFORMED

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Circulating Fans

A new line of circulating and cooling fans designed for use in hazardous locations is announced by Ilg Electric Ventilating Co.

The units feature explosion-proof motors with Underwriters' Laboratories approval for all Class 1, Group D installations: gasoline, alcohol, and lacquer solvent fumes, propane and butane gas.

The motors are constant-speed types. Available are 115- or 230-v, 1-phase, 60-cycle units, and 220- or 440-v, 3-phase, 60-cycle units. Fan wheels are nonferrous, and said to be scientifically shaped and designed to move more air more quietly. The units are furnished with explosion-proof starter mounted and wired to the motor with rigid conduit. Explosion-proof cable and cable connector are available.

Models are available with predestal base for floor use, or with wall or ceiling mounting. The firm says a new tilting head can be adjusted to change the angle of air flow.

Solenoid Valves

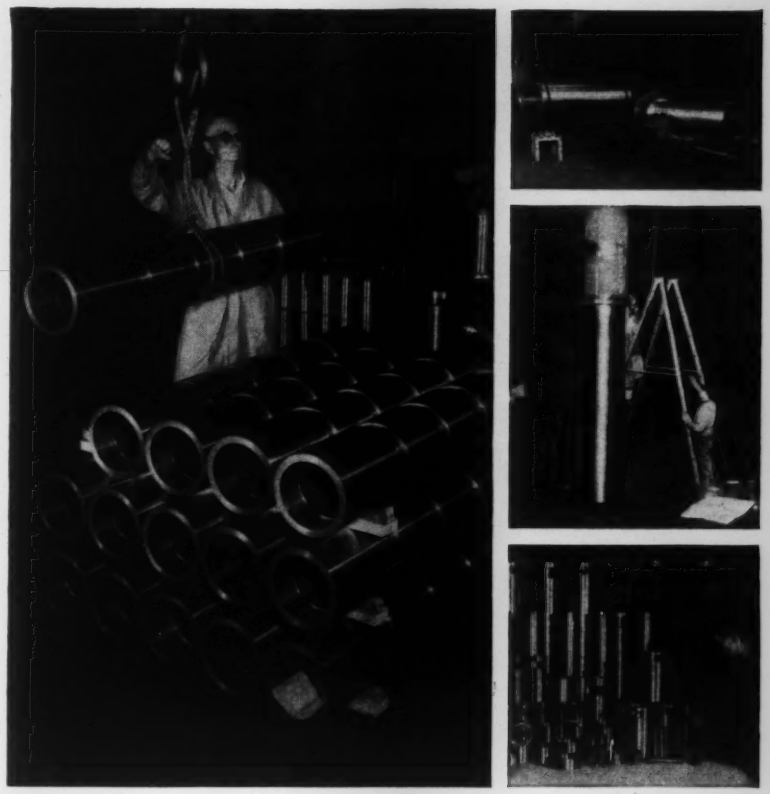
A new line of miniature, small-ported, two-way, and three-way direct-acting solenoid valves with brass or stainless steel bodies has been introduced by Hoke, Inc.

Designated Series 90 for two-way types and Series 95 for three-way types, the versatile valves feature several innovations in miniature solenoid design, including a-c shading coils of fine silver; fully rotatable coil housings for electrical connections from any angle; ability to operate equally well in any mounted position and a broad selection of pipe and tube connections. Considered by the firm to be the smallest solenoid valves currently available, they average several ounces less in weight and are extremely quiet in operation.

Orifice sizes for Series 90 two-way types range from $^1/_{32}$ to $^1/_8$ in., with differential pressure ratings as high as 2000 psi. Series 95 three-way types have orifice sizes from $^1/_{32}$ to $^1/_{16}$ in., with differential pressure ratings to 300 psi. Two-way types are available in normally-open and normally-closed designs; three-way types also include a universal flow pattern for less critical application as either normally-closed or normally-open.

Coils are designed for continuous duty, with Class A or H coils available for varying temperature applications. Windings are designed in accordance with UL requirements for operating at 10 per cent over and 15 per cent under rated coil voltage.

For Consulting Engineers
Turn to Page 180



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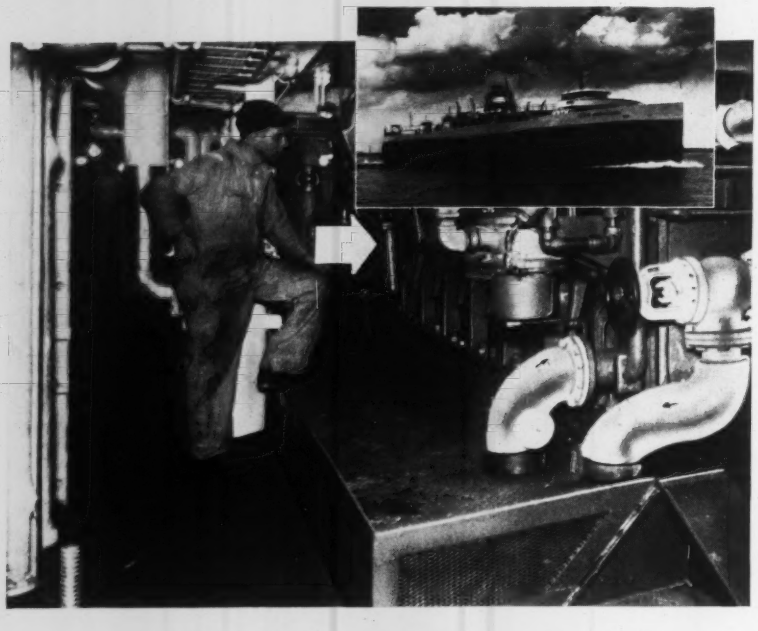

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One of the most unique vessels now plying Lake Michigan is the railroad carferry, *M/V Arthur K. Atkinson.* Prior to complete renovation and repowering with Nordberg Diesels, this vessel was the 43 year old, steam powered *Ann Arbor No. 6.*

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BUSINESS NOTES
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Package Brushless Generator

A new package brushless generator designed to eliminate sparking has been announced by Allis-Chalmers for applications in oil well drilling, hospitals, construction projects, ship board, radio and TV stations, mines, quarries, factories.

The generator has its auxiliary equipment compactly mounted within the yoke enclosures. The firm says this design permits direct mounting of a switchboard on top of the unit, keeping cable runs to a minimum length.

The conduit space is located on top of the generator to provide an enclosure which is integral to the frame. Instruments are at a readable height and placed in a side recess, which also shelters a forced cooled, completely static, current compounded voltage regulator. Conduit entry can be made from left or right hand by means of removable plates adding to the generator's flexibility.

The voltage regulator provides strong field forcing to minimize voltage deviation at the generator terminals.

Chain Lubricators, Cleaners

Oil-Rite Corp. has developed a new line of chain oiler brushes which incorporate a mechanical bond on the bristles to prevent them from coming loose, and improve the wearing qualities of the brush.

Bristle materials are now available in horsehair, for normal lubricating applications; nylon, for high-speed chains where greater wear resistance is desired; stainless steel, for high temperature lubrication and chain cleaning.

They are available in diameters of— $\frac{5}{8}$, 1, $1\frac{1}{2}$ in. and $\frac{3}{8} \times 2\frac{1}{4}$ in. widths. The firm says the stainless steel brushes provide a new concept in chain cleaning methods. A stainless steel shank brush precedes the lubricating brush and wipes the chain clean, followed by the application of a protective film of oil.

Cork-Silicone Rubber

Formulation of a new compound combining cork and silicone rubber has been announced by the Armstrong Cork Co., Industrial Div.

This material, known as LC-800, is said to combine the advantages of cork with silicone rubber for the first time. It allows the gasket designer to use cork and rubber gaskets at much higher temperatures than heretofore possible.

In addition to extending the temperature range of cork and rubber materials, LC-800 is considerably less expensive than straight silicones, the company reports. It can be made in ribbon and lathe cut rings, both extruded and laminated, as well as mats, sheets, and die-cut parts.

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Lubricating Unit

A packaged lubricating unit designed with built-in safety features, is announced by Nordberg Mfg. Co.

The new Protecto-Lube system, primarily designed for Symons cone crushers and available with new units, can be adapted to crushing and processing equipment now in the field as well as to other types of mechanical equipment, the firm reports. Lubricant to the equipment is under constant, controllable pressure and temperature and filtered before returning to the oil circulating system.

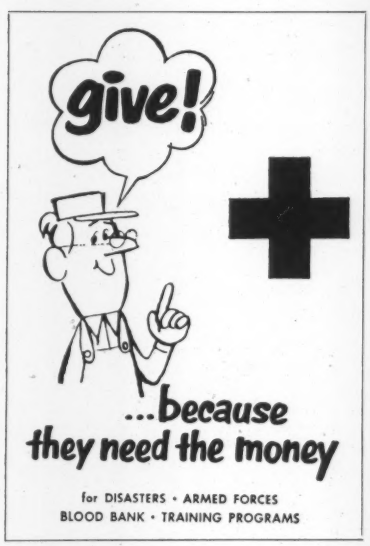
Built in three sizes, the units are available for 10, 25, and 50 gpm output, with an available operating range of 20 per cent above and below this figure, based on 500 seconds Saybolt universal lubricating oil at 100 F and 50 psi pump outlet pressure.

Variable Speed Transmission

New Models 65 and 70 frame Varidrive, variable speed transmission and integral motor, were recently released by U. S. Electrical Motors. The new models will be used for ratings between 30 and 60 hp with a more rugged and compact design.

Model 65 is a single belt drive rated to 40 hp with up to 6:1 speed variations giving more versatility than ever before. Capable of 60 hp, the 70 frame unit has dual belts and is also available with up to 6:1 speed variations. Both models feature a sturdy subbase construction to permit upright or horizontal mounting.

As optional equipment for the new frames, a new Type GB gear reducer can be integrally mounted for reduced speed, high torque applications, the firm reports.



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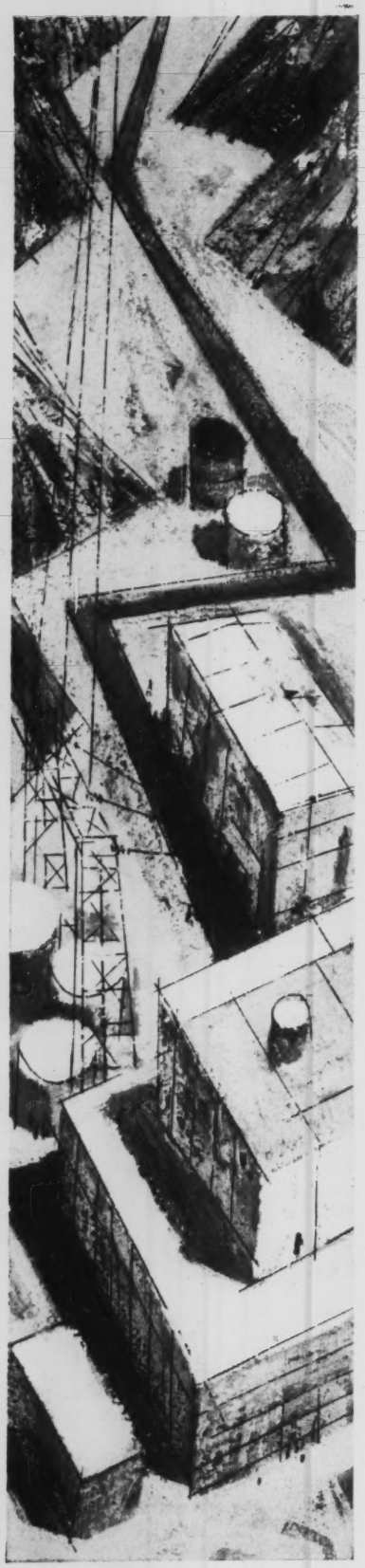

Engineering Analysis Positions

Sodium, Organic, Special Purpose and Research Reactor Programs

Rapidly expanding reactor development programs have provided additional challenging assignments at Atomics International. AI's modern headquarters and plant facilities, located in the San Fernando Valley of Southern California, have become a world-wide center of nuclear reactor development. Here, qualified scientists and engineers have a sound future and unlimited opportunities to advance. Currently, openings exist in:

Reactor Engineering. Analysis and design of complete power reactor systems and components. Experience in power reactor systems and technology is preferred, including a knowledge of reactor safeguard methods.

Core Analysis. Complete nuclear analysis, including criticality determinations and flux distributions. Must also be conversant with fuel economics and fuel cycle optimization.

Shielding. Design and analysis of biological and thermal shielding for large power plants and compact mobile systems.

Heat Transfer and Fluid Flow. Steady state and transient experimentation and analysis. Power optimization studies; free and forced convection flow transients; boiling and two phase flow in water, organic and liquid metal systems.

Structures. Advanced analytical studies in thermal stress analysis, structural dynamics, elastic and inelastic behavior of plates and shells. Structural analyses are performed for transient and steady state operating conditions involving mechanical loads, thermal cycling and thermal shock.

Control. Includes analysis of complete plant control and the application of electronic analogue and digital computers to reactor systems. Experience in radiation monitoring and plant protection systems is necessary.

For specific details write: Mr. A.G. Newton, Personnel Office, Atomics International, 21600 Vanowen Street, Canoga Park, California.

ATOMICS INTERNATIONAL

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Fuel and Materials Development

Senior Metallurgist, Physical Chemists and Engineers

Reactor Materials. Research involves investigation and analysis of mechanical and physical properties of metallic alloys and inter-metallic compounds. Materials are to be used in power reactors for fuel, and fuel cladding, moderators, control rods, and structural members. Studies will include analysis of materials after exposure to high temperatures and radiation fields.

Fuel Element Engineering. Responsible for the complete analysis and design of fuel elements. This includes nuclear, thermal, material, mechanical and cost analyses. Should be familiar with fuel life determination methods and reprocessing techniques.

Fuel Fabrication. Activities will include development fabrication of materials and fuel elements, for both plate and rod forms and complex assemblies. A knowledge of non-destructive testing methods is essential, in addition to familiarity with a wide range of material processing and fabrication techniques.

Irradiation Experimentation and Hot Lab Evaluation. Senior Research Engineers and Physicists are required to design and conduct irradiation experiments on developmental materials including reactor fuels. The individuals must be familiar with a wide range of radiation and temperature conditions. Experimental conditions will include the simulation of conditions expected in full scale power reactors. Also senior personnel are needed to develop equipment and techniques required for the post-irradiation testing and evaluation of these experiments.

For specific details write: Mr. A. G. Newton, Personnel Office, Atomics International, 21600 Vanowen Street, Canoga Park, California.

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NEW EQUIPMENT
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Variable Hydraulic Pump

A variable delivery 5 gpm vane pump has been made available for industrial applications, according to an announcement from Vickers Inc., Div. of Sperry Rand Corp. The new pump includes an integral pressure compensator which controls pump volume at preselected adjustable pressures.

Designed for pressures up to 1000 psi, the new pump limits its delivery to system demand. Maximum delivery can be limited by means of a mechanical adjustment. Pressure compensation can be varied from 200 to 1000 psi.

The company says sharp cut-off characteristics enable the pump to deliver nearly full volume up to the compensator setting even at low operating pressures. Variable volume and pressure compensation features eliminate the necessity for a relief valve and attendant piping. Nominal 5 gpm rating is at 1800 rpm. Maximum pressure rating is 1000 psi. It is available for flange, foot or gasket mounting.

Digital Magnetic Tape

Magnetic tape for either analog or digital data recording is now available from the Data Tape Div., Consolidated Electrodynamics Corp.

The newly developed Mylar-based tapes are manufactured, tested, and spooled to specifications equal to or better than MIL T-21029 and available in $\frac{1}{2}$, 1 and $1\frac{1}{4}$-in. widths, 1-mil or 1.5-mil thicknesses, and lengths from 2000 to 7200 ft. Reel diameters are $9\frac{1}{2}$, $10\frac{1}{2}$, and 14 in. Tapes and reels meet or exceed military and National Association of Radio and Television Broadcasters specifications. A selection of 19 tapes is offered, and special sizes and types will be made on order.

Plastic Switches

Haydon Switch Inc. announces an expanded line of 19 precision snap-acting switches in its new 5200 series. Ten models, with actuating button in center position, cover an operating force range of 3 to 20 oz.

The switches are qualified to the basic snap-action switch specification MIL-S-6743 and the vibration requirements of MIL-E-5272A, Procedure II, the firm reports.

An additional nine switches, with actuating button in off-center position, feature extremely low operating forces. Furnished with pin, integral wire or flat leaf actuators, these models cover an operating force range of 2.5 to 60 g. Auxiliary actuators are also available.

All switches have electrical terminals molded in place for maximum rigidity and resistance to movement. The symmetrical housing, with two covers, ensures dimensional uniformity and stability. This close dimensional control is designed to minimize build-up of tolerance and make the new switches especially suited to ganging in multiple circuit applications.

Self-Tap Screw

A new type screw for use in sheet metal, plastic, and wood which both drills and taps its own hole is being announced by Reliance Div., Eaton Mfg. Co.

Named the self-drill, self-tap screw, this new unit is now available in a limited range of sizes for trial use by manufacturers. It is designed for power driving, and is said to be ideally suited for both manual and automated assembly operations.

The screws can also be preassembled with various types of plain, special and lock washers and sealing washers to meet user's requirements for specific applications.

Definitions of Occupational Specialties in Engineering

This book contains comprehensive data related to all activities and specializations in engineering including specific knowledge and duties, responsibilities and related techniques necessary for successful performance in each field.

The ten activity fields defined are research, design, development, testing, procurement, production, construction, operation, administration, and teaching.

Major engineering fields of specialization defined include aeronautical, automotive, ceramic, chemical, civil, electric and electronics, guided missiles management, marine, materials, mechanical, metallurgical, mining, naval, nuclear reactor, ordnance and armament, petroleum and fuels and power plant engineering. Other engineering fields defined are: packaging, photogrammetry, agriculture, geology, and geophysics.

Pub. 1952 Price: $2.50, 20% less to ASME members.

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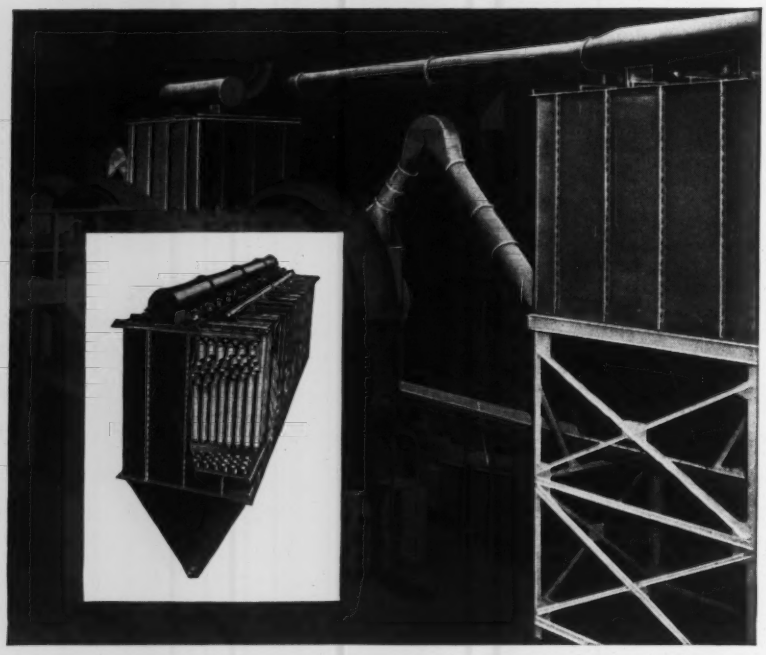

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Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Industrial Specialties

A colored wall chart on industrial specialties, listing specifications in quick reference form on die barbering wheels; sticks, stones and rubs; and finishing compounds, is available from Carborundum Co.

Liquid Level Gages

Jerguson Gage & Valve Co. announces a bulletin on nonfrosting liquid level gages.

Information on the special patented construction, other design features and specifications is covered in new data unit, No. 351. The special construction guarantees that the vision slot will not frost over in gaging low temperature liquids.

Plastic Tube Pilots

Light tube pilots, costing approximately one-tenth as much as previous models, have been developed by Thomas C. Wilson, Inc. for use with heat exchanger and boiler tubes ranging from $^3/_8$ to 1 in. OD.

The firm reports that the pilots are used to speed assembly of tubular equipment by piloting tubes through tube sheets, baffles, and support plates. Piloting prevents damage to tube ends and eliminates the need to fish tubes through misaligned tube holes.

The new Guide-Rite pilots are made entirely of plastic. They are designed to do the same job, within their application range, as much heavier and costlier models, the company says. The plastic pilots have a spring pressure feature designed to hold them securely in place, yet make removal easy.

Switching Units

Announcement of a new standardized line of packaged electromechanical units for efficient electrical control of linear machine movements has been made by the Linear Controls Co.

Designed as aids to automation, the new units reportedly effect savings of up to 50 per cent over custom-made installations.

The company says its unique design provides self-contained units in which two two-circuit double-break snap action switches are operated by adjustable cams mounted on a rigid, heavy-walled sliding actuator tube, which is coupled to an air cylinder or sliding machine member. Movement of the cylinder operates the switches at pre-set points, and controls those machine members that are operated electrically through the switches.

Utilization of standardized actuator bars and cams means closer alignment in relation to mounted switches, and less deflection in the internal action of the switches, thus resulting in longer switch life, the firm states.

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Grinding Attachment

Henry Owens & Co. is now manufacturing a 616 cylindrical grinding and indexing attachment, which was formerly manufactured by Brown & Sharpe Mfg. Co.

This attachment is used for dry grinding small cylindrical work, tapers, and work requiring indexing on surface grinders. Grinding is done on dead centers. Work driving dogs with specially designed driving arms hold work without backlash, when indexing is required.

For work not ground between centers an indexing spring chuck with spring collets is available, interchangeable with standard index head. The motor is completely enclosed; ball bearings in index head and indexing spring chuck are permanently lubricated and sealed.

Anti-Galling Lubricant

A specialized lubricant said to prevent galling and corrosion of tapped threads and to serve as an effective anti-friction, anti-seize compound for certain metalworking, general industrial, and marine applications, is announced by Keystone Lubricating Co.

The firm says the product protects drilling equipment—jackbits, drill rods and couplings, oil well casings, and drill pipes—against thread damage due to corrosion, stripping, and galling.

In general industrial use, it protects machine slides and lathe dead centers from excessive frictional wear, serves as a superior drawing and forming compound, provides an effective moisture-resistant gasket seal, and virtually eliminates the possibility of seizing and galling in press fitting operations, keyway lubrication, and other high pressure applications.

In the marine field, this lubricant provides effective lubrication for such equipment as clevises, turn buckles, and standing falls.

It is called No-Gall and is a special zinc-base lubricant made in plastic consistency for brush or paddle application. It does not dry out or harden.

Relief Valve

Watts Regulator Co., announces a new large capacity, ASME rated combination T&P relief valve.

The No. 340 is equipped with a test lever and has $1^1/_2$ in. female inlet and outlet connections. Features include all bronze construction, guideless stickage-free seating design, and extremely high capacity.

Its ASME steam pressure rating is 5,707,000 Btu per hr at 125 lb, and the temperature water rating is 3,500,000 Btu per hr. Said to be the only valve of its type available, the firm states it can be installed on larger installations which previously required two or more smaller valves for sufficient capacity.

The Bellows You Need *Hasn't Yet Been Made!*

Your design is *new* — not a collection of stock items. Nor can your critical requirements be met by stock bellows.

Your bellows function is dependent on endless variables of temperature, pressure, atmosphere, stress.

The correct bellows assembly must be specifically designed for the job — and Robertshaw engineers are at your elbow with more *bellows answers* than anyone else!

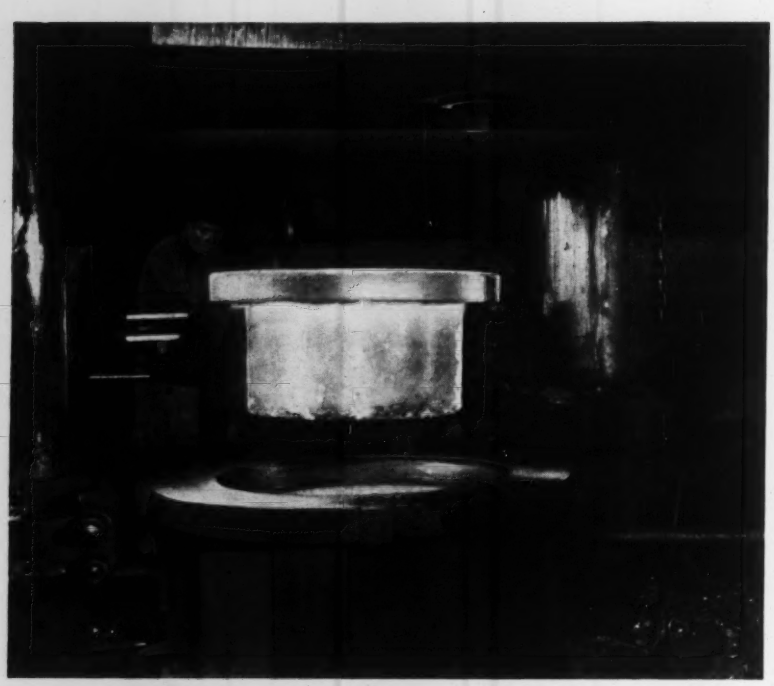
Bellows can be brass, phosphor bronze, beryllium copper, monel, stainless steel, inconel, inconel-X . . . or other special metals to meet a critical situation.

NEW BOOKLET! *For technical data on Sylphon® Bellows — and cost-saving Bellows Assemblies — write for just-issued catalog* **NKR**

Mr. Controls

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tennessee



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For pressure vessels, Lenape gives you the widest choice of seamless forged welding connections that meet your requirements for:

TYPE—Your choice of Seamless Long Welding Necks; Type H Heavy Reinforcing Necks; Studding Outlets; Type S Nozzles; new Seamless Welding Extensions; Internal or External Reinforced Nozzles; ASA Flanges and new Dished Blind Flanges.

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LOW COST. Specialized manufacturing techniques make even standard LENAPE Seamless Welding Necks cheaper than fabricated necks in most sizes—plus the wide variety of low cost connections available exclusively from LENAPE.

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See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Speed Reducers

A new model in its Hi-Line series of fin and fan cooled speed reducers has been announced by Ohio Gear Co.

The model, designated the P series, features specially designed cooling fins plus a powered cooling fan said to provide up to 80 per cent greater load capacity than comparable, non-ventilated models. The firm says an additional advantage of the new design is space saving characteristics which allow far greater capacity in less space.

The new series is of the right angle, vertical style employing a worm and gear reduction. It is available with a low base; with a high base or with no base depending on end use requirements. It is also available in two types of NEMA C-flange motor mounts.

Sizes range from 1.33 to 5.25 in. center distance with a variety of standard reductions ranging from 1:1 through 60:1. The new series, which is priced competitively with other units of similar size and quality also features heavy capacity anti-friction bearings, short center distance between worm and gear and improved heat dissipation characteristics.

Fluid Flow Controls

A new line of purge rotameters introduced by Schutte & Koerting Co. is designed to measure and control fluids flowing at small rates.

The standard units in the line use stainless steel and other corrosion-resistant materials for fluid-contacting surfaces; special models are also available in Kel-F or Lucite construction.

Nine capacity ranges are obtained by selecting from a series of interchangeable tubes and floats for use in the same basic body. The smallest capacities available over a 10 to 1 range are 0.6 gph of water or 0.50 scfh of air (metered at 10 psig). Capacities of the largest units are 12 gph of water and 70 scfh of air, (metered at 10 psig).

The company says the units find application in preventing process fluid from entering connecting piping and sensing elements of instruments.

Metal Processing

A complete metal processing service, ranging from the design, installation and service of a variety of metal preparation and finishing machines to the compounds and chemicals themselves, is now being offered to the industry by Pennsalt Chemicals Corp.

The equipment in the line runs from small agitating washers and wash-and-rinse cabinets, the only standard models offered, to large phosphatizing machinery, spray coaters, dryers, and other machines which are custom-designed for each manufacturers' specific needs.

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BUSINESS NOTES
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Temperature Regulator

Barber-Colman's new temperature regulator for proportional control of water, gas or low pressure steam is designed for all applications where a self-contained valve assembly may be particularly suited.

It is described as a tight-closing, ruggedly constructed, unit, offering all the installation advantages of a self-contained controller, with the additional features of a calibrated adjusting dial for precise temperature control, an electric industrial motor operator, and armored capillary tubing.

Applications suggested by the company include package air conditioning units, hot water storage tanks, plating tank control, industrial process control, and bottle washers.

No assembly, linkage, or adjustment is necessary either before or after installation—except for the setting of the control dial to the exact desired temperature, the firm reports.

Self-Threading Nuts

An acorn type has been added to the line of Palnut self-threading nuts, which form their own deep, clean threads while tightening on unthreaded studs, rod, wire, or rivets of aluminum, zinc, steel, brass, or plastic.

Sizes presently available are for $^1/_8$ and $^3/_{16}$ in. diam. Made of tempered spring steel, the Type CST self-threading nuts have a decorative dome shape that covers the ends of studs or rods to add a pleasing appearance and protect against scratching. The central opening is a double, coarse pitch thread form which acts like a die in starting and forming a continuous spiral thread impression as the nut is turned down in assembly. High tensile and torque values are provided, while resilient spring forces assure a strong, vibration-proof grip, whether seated or unseated. They apply with standard assembly tools or with high-speed Palnut magnetized wrenches, and may be removed with a wrench and re-used on the same assembly.

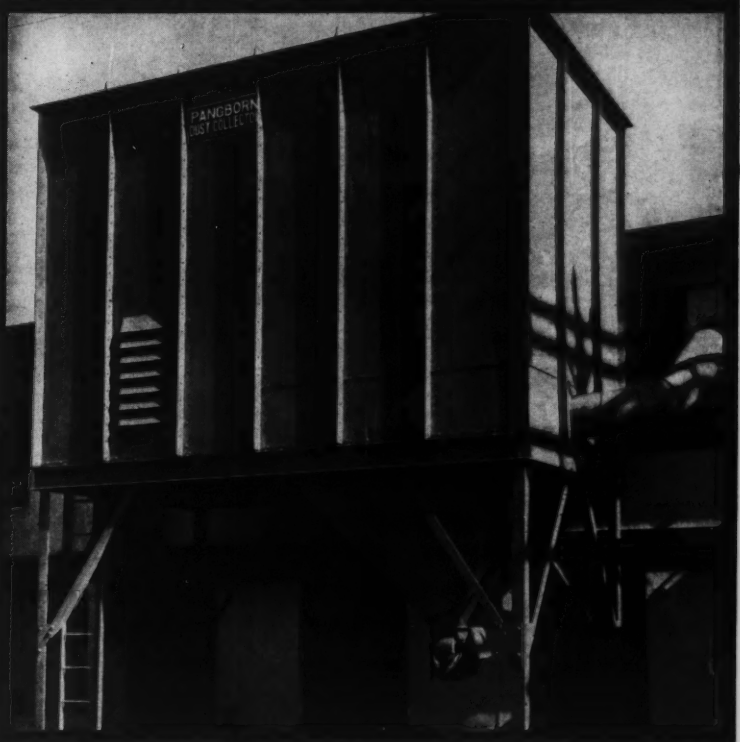
Electric Clutches

Warner Electric Brake & Clutch Co. announces three new electric clutches, called SF-80 clutches, specially designed for use with timer cams designed and built by Avionic Div., John Oster Mfg. Co. for air-to-air missiles.

The clutches, compact and durable, provide a simple, foolproof method of coupling the right clutch to its imput shaft at the exact time, a very important factor, because the motor runs continually and the three input shaft are constantly rotating.

Also important is its satisfactory field which is easier to install because it doesn't require collector rings.

TRAPS ALMOST 4 CU. FT. OF DUST PER WEEK



One small Pangborn Dust Control system replaces 8 collector units profitably at Precision Rubber Products

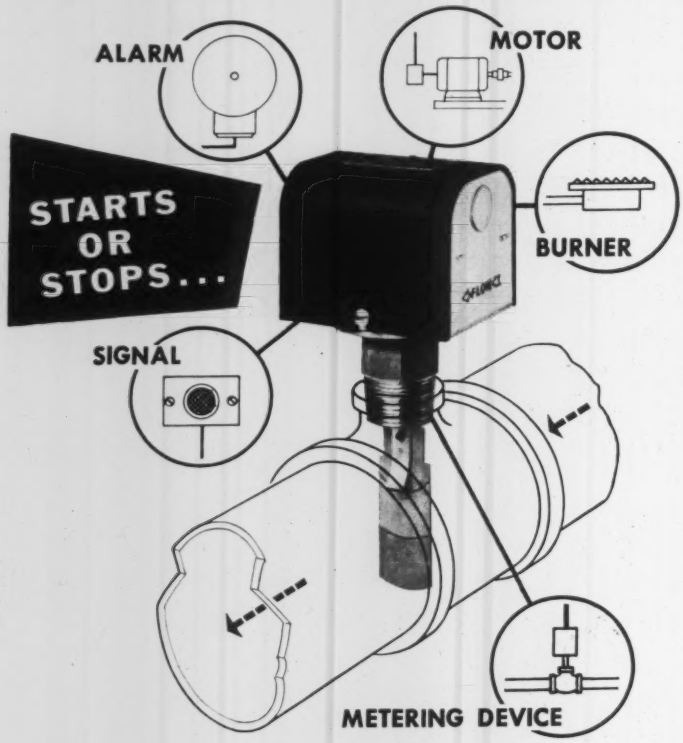
At Precision Rubber Products Corporation, Dayton, Ohio, millions of seals pass through a buffing process every year. The resulting dust could constitute an operating and housekeeping hazard. To facilitate dust control, the company replaced eight individual collector units with a central Pangborn Dust Control system. This installation saves floor space, operates quietly and gives efficient dust control (trapping almost 4 cu. ft. of rubber dust per week). Dust is now removed from *one* collector hopper instead of eight individual hoppers.

If dust is a problem in your plant, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment—Rotoblast® Steel Shot and Grit.*

Pangborn CONTROLS DUST

Makes or breaks a circuit when flow STARTS . . . or STOPS

McDonnell FS4 Series Flow Switch



The illustration tells the story of the McDonnell FS4 Flow Switch. Installed in a pipe line, it is a moderately priced, highly dependable device that makes or breaks a circuit when flowing liquid moves the paddle—to perform almost endless functions vital to safety and automatic operation. Underwriters' Listed.

New Bulletin FS-1 fully covers all details of construction and service ranges. Also contains typical applications that may suggest important services the FS4 Flow Switch can perform in your plant.

McDONNEL & MILLER, Inc., 3510 N. Spaulding Ave., Chicago 18, Ill.

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SAFETY CONTROLS REG. U. S. PAT. OFF.

McDONNELL *Flow Switches*

Boiler Water Feeders • Low Water Fuel Cut-Offs
Pump Controllers ○ Relief Valves • Related Liquid Controls for Tanks, Stills, Air Conditioning Systems

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Air-Operated Tool

A new, air-operated Impactool, with a 1-in. drive, has been designed by Ingersoll-Rand to give the mechanic 350 per cent faster rundown and 25 per cent more power. The new, direct drive between motor and hammer is reported to take maximum advantage of inertia of rotating parts.

Main application for this tool is for heavy truck wheel work and spring U-bolt jobs. The size 434 Impactool, as it is called, is $10^{1}/_{8}$ in. shorter and 9 lb lighter than the previous model. The lighter weight and reduced size are factors in enabling the mechanic to work in tight spots where full power is still required.

Liquid Level Control

A new liquid level control pilot with an adjustable proportional band has been developed by Leslie Co.

The firm says that by means of a single knob adjustment, the proportional band can be quickly set while the liquid level system is in operation without affecting the liquid level set point.

Employing the differential pressure sensing method, it is unaffected by surface turbulence and does not require floats, cages, linkages, torque tubes or stuffing boxes. Never more than two small connections to the vessel are required, the company states.

Transfer Machine

A new seven-station transfer machine that performs boring and precision line boring operations on large cast iron V-12 truck engine blocks at a rate of 31 pieces per hour at 100 per cent efficiency has been designed and built by Snyder Corp.

The 35-ft long hydraulically operated, electrically controlled machine receives blocks from the factory conveyor. The blocks are automatically loaded into the machine and transferred through the various idle and machining stations by a walking beam type of transfer mechanism. They are automatically placed back on another factory conveyor after processing in the transfer machine.

The crankshaft and camshaft bearings are line-bored simultaneously in two stations of the machine. Way-type machining units with a 60-in. travel retract the long boring bars so that the blocks can be loaded into the fixture at the machining stations. Each boring bar is supported by several fixed bearings in the fixture during the boring operation. The firm says this requires an unusual fixture and transfer mechanism design to enable the blocks to be positioned over the supports for the crankshaft bearing boring bar. The bearing supports for the camshaft boring bar are lowered into the block as it is clamped down in machining position.

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Pneumatic Vibrator

Cleveland Vibrator Co. has announced a massive new pneumatic vibrator delivering 16,000 lb of impact.

Used principally on vibrating tables, hoppers, large bins, railroad car shake-out, and special packaging platforms, the 7 in. Model FAC operates on 60–80 lb of air pressure and the 176 lb piston has an $1^1/_4$ in. stroke.

Vibrator speed and intensity can be varied according to needs, and unit can be rigged to operate continuously or intermittently. Reciprocating action of the piston is air cushioned for quiet operation on applications where noise is an objectionable factor. Entire weight of this vibrator is 539 lb.

Plastic-Coated Valves

DeZurik Corp. has announced that its eccentric valves are now available with plastic coatings designed to improve the corrosion resistance of cast iron at only a slight increase in price.

The firm says the coatings make the valve suitable for neutral salt solutions, alkalies, alkaline salts, mild acids, and many other services. They are also an economical answer to iron contamination in water distillation, demineralization, and deionization systems, the company reports.

The valves work on the principle which pivots the plug eccentrically in the valve body to match an eccentrically-raised seat. The plug touches the valve body only when the valve is closed.

The company says plug friction is eliminated and the resilient faced plug eliminates the need for lubrication to achieve tight shut-off.

Porous Metal Disk

New porous metal filter disks, constructed completely of stainless steel fibers, have been announced by Purolator Products, Inc.

Designed for relatively (restricted) low flow and high contaminant/or product collection, the new porous metal filter disk consists of two cylindrical sheets of highly ductile fibrous stainless steel (Type 430). Drainage members and closures are constructed of Type 304 stainless steel.

The fibrous porous metal disk has an extremely high permeability, a pore size of 10 μ, and measures $^1/_{16}$-in. thick, 10 in. OD, and 3 in. ID, providing an effective filtering area of approximately one sq ft.

The company says the disks are designed for operations with wide temperature ranges, differential pressures to 200 psi plus, and resist all effects of most concentrations of nitric acid, either when filtered through the disks or used for cleaning purposes.

80% More Capacity—Far Less Space

HI . . . in capacity — will handle up to double the load.

HI . . . in versatility—More load with no increase in size or weight.

HI . . . in performance — Fin and fan cooled for greater capacity with less heat rise.

HI . . . in value — all new design for long life and minimum maintenance.

HI-Line reducers are available in six new series ranging from 1.33″ to 5.25″ centerdistance. Standard models in each series include vertical with high or low base, and horizontal models with worm upper or lower.

Get Your Free Catalog — 186 pages packed with useful information on gears and speed reducers

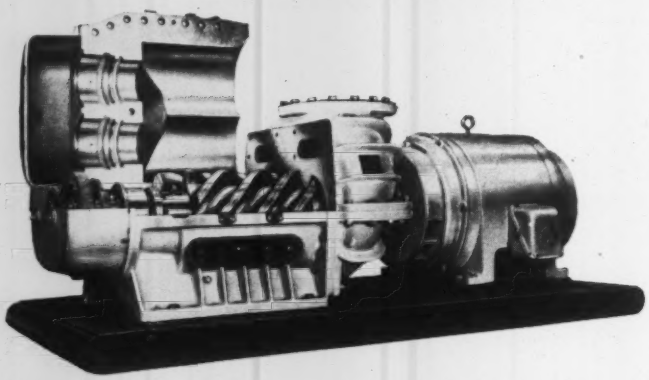
Manufacturers of gears and speed reducers - both stock and special

Ohio

You'll find this is

the only rotary compressor

with all these features!



Fairbanks-Morse Positive Displacement Axial-Flow Rotary Compressors are available in standard models in single-stage units, with capacities from 800 to 12,500 cfm. at compression ratios from 1.6:1 to 5.0:1—or in two-stage units with capacities from 2,000 to 12,500 cfm. at compression ratios above 5.0:1—and for booster service at maximum working pressures up to 250 psig.

- **High efficiency and stability** that rivals reciprocating machines.
- **Low weight and small space** requirement that cuts costs for installation, foundation and building.
- **Oil-free output**—no metal-to-metal contact of impellers or casing, no lubrication of parts contacting gas, air or vapor.
- **Mechanical simplicity**—no valves, no pistons or reciprocating parts to wear or replace.
- **Adaptability to any power source** permits choice of induction or synchronous motor, diesel engine, gas or steam turbine as prime mover.
- **Smooth, steady operation**—impeller speed and design produce even delivery of flow with minimum pulsation or vibration.

For complete information contact your nearby Fairbanks-Morse Branch, or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill. Ask for new Bulletin ACO 100.2.

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COMPRESSORS • PUMPS • SCALES • DIESEL, DUAL FUEL AND GAS ENGINES
LOCOMOTIVES • ELECTRIC MOTORS • GENERATORS • MAGNETOS • HOME WATER SYSTEMS

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Antifriction Bearing

Scully-Jones & Co., announces the acquisition of the complete line of Tychoway bearings, a new recirculating roller-type bearing for friction-free linear positioning.

The company says flat, compact design and the recirculating principle used in the Tychoway spreads heavy loads over a larger surface, avoids single-point contact that wears or pits easily under high unit pressures. Preassembled, modular construction from 52100 bearing steel permits mounting directly on precision machined flat surfaces, eliminates hand fitting of slides, costly way shaping, the firm states.

Wet Blaster

A new wet blaster has been added to its Tamco line of precision-built automotive and industrial equipment by Tobin-Arp Mfg. Co.

Called Liqui-Breez, Model LB-1002, the new wet blaster is designed to perform the following operations: honing, cleaning, deburring, and blending.

In honing, the firm says, the cutting efficiency of high speed steel and tungsten-carbide cutting tools can be increased as much as 500 per cent. In cleaning, the unit removes all minute particles and foreign matter from metal surfaces. In deburring, this method is said to be highly successful in removing both loose and tight burrs. In blending, directional lines caused by machining and grinding can be easily removed, preparing surfaces for plating or painting.

Size of the floor model is 67 in. high. The cabinet is 24 in. diam, with a floor working area of approximately 10 sq ft. Working area inside cabinet is 380 sq in.

Fasteners, Tools

Huckbolt fasteners in $^5/_8$ and $^3/_4$-in. nominal pin diameters, together with required installation tooling, are now available from Huck Manufacturing Company.

The fastener line is thus extended to cover a size range from $^3/_{16}$ to $^3/_4$-in. The new fastener sizes are currently being produced in aluminum alloy (2024), mild steel (AISI 1038), and stainless steel (300 series).

Tooling for installing the new fastener sizes include the new Model 504 and Model 505 hydraulic installation tools and Model 905 Powerig, a portable hydraulic power unit. The Model 504 tool has a capacity of 16,000 lb pull with a $1^1/_2$-in. pull stroke. It will install up to $^1/_2$-in. mild steel and $^5/_8$-in. aluminum fasteners.

The Model 505 tool has a capacity of 33,000 lb pull with a 2-in. pull stroke. It will install up to $^3/_4$-in. mild steel Huckbolt fasteners.

The new Model 905 delivers hydraulic power at operating pressures up to 5000 psi from 220 v or 440 v 3-phase electrical input. It will operate either the Model 504 or Model 505 installation tool.

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Limit Switch-Stop

Precision Mechanisms Corp. announces the LS302, a new infinitely adjustable limit switch-stop for the servo and instrument industries.

The new component features a single exterior range adjustment screw which permits rapid adjustment to any angular rotation from 0 to 25 turns. Limit switches are actuated at either end of shaft travel just prior to contact with non-locking limiting stops.

The switch-stop is .937 diam by 2 in. overall length. Shaft diameter is .125. Other features are its torque capacity of 40 oz-in. at end stops, its low operating torque and its low inertia. Construction is of corrosion resistant steel and anodized aluminum alloy and conforms to all applicable sections of MIL-E-5400.

Exhaust Fans

A new line of exhaust ventilating fans engineered and designed to provide maximum exhaust per horsepower used has been developed by Binks Mfg. Co.

The fans are designed for exhaust hoods and oven air seals and will function at top efficiency at temperatures ranging from −40 to +400 F. Fan housings are available with single mounting ring or with double flush rings. Drive motors are mounted outside the duct on a base which provides belt take-up.

Both the V-belt and the fan pulley are enclosed in a dust and vapor tight housing. All fans are of the six blade aero type, precision mounted on a steel shaft, which in turn revolves on high temperature ball bearings. Bearing lubrication is provided for through a grease cup.

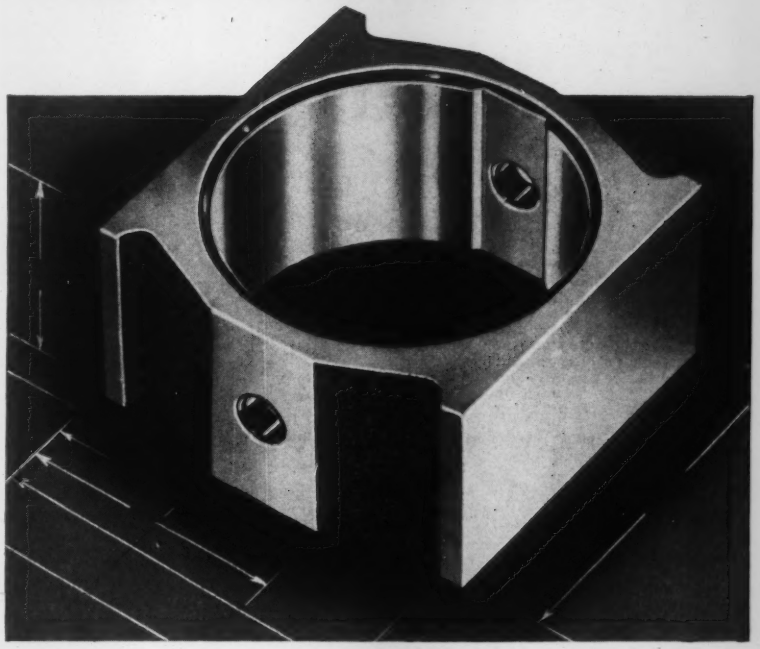
Motor horsepower requirements range from 1/4 to 7.5. Fan and pipe sizes range from 18 to 42 in. Free air delivery ranges from 3180 cfm to 29,500 cfm. All units are FM approved when used with totally enclosed or explosion-proof motors. Performance ratings are in line with the standard test code for centrifugal or axial fans, the firm states.

Cam Index Drives

A two-page engineering data sheet, No. 157, describing a line of standard cam index drives that provide accurate, smooth, rapid and shock-free indexing of heavy duty work tables on dial and trunnion type machine tools is now available from Expert Automation Machine Co.

Included in the data sheet are features, operating descriptions, application data, and dimensioned engineering drawings of the I-5A, I-10A, and I-15A model cam index drives for table sizes ranging from 20 to 100-in. in diam.

many difficult requirements...



We illustrate the cast bronze cam block for a hydraulic pump operating the hydraulic lift mechanism on an exceedingly well-known line of farm tractors.

The manufacturer of this equipment has very unusual specifications for this cam block. Its bore has a very fine finish specification. It also must be round and true to size within unusually close limits. In addition, it must be square to the face of the cam block within limits that ordinary methods of manufacture will not attain.

Bunting methods of manufacture result in a part which is completely to the customer's exacting specifications.

For the unusual, as well as the usual, in bearings, bushings, bars, or special parts of cast bronze, sintered metal, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

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BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

SIX NAGLE PUMPS drain ADIRONDACK OPEN-PIT IRON MINE!

The Nagle 10" Type "CWO-C" vertical-shaft pump shown is draining the open-pit iron mine of Jones & Laughlin Steel Corp. at Star Lake, New York—of water frequently heavily charged with solids. Its selection was based upon the good performance of other Nagle drainage pumps in their operation since 1944.

Nagle pumps are designed exclusively for abusive applications—handling abrasive or corrosive solutions or hot liquids. They have established brilliant performance records, cutting costs in mines, mills, quarries, and chemical processing plants. Learn more about them—send for Nagle Pump Selector.

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1299 CENTER AVE., CHICAGO HEIGHTS, ILL.

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PUMPS FOR ABRASIVE AND CORROSIVE APPLICATIONS

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▶ Evaporating a very small amount of water in an air stream you can cool liquids, gases or vapors with atmospheric air, removing heat at the rate of input, controlling temperature precisely. Save 95% of the cost of cooling water; save piping, pumping and power. You quickly recover your equipment cost.

You can cool and hold accurately the temperature of all fluids, condense vapors, cool water, oils, solutions, intermediates, coolants for mechanical, electrical or thermal processes. You have a closed system free from dirt. You have solved all problems of water availability, quality or disposal, maintenance expense is low.

You may apply this to solvent recovery, vacuum systems controlling reactions, condensing distillates, cooling reflux products.

For more information, write for Bulletins 120, 124, 135. Address Dept.

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Solenoid Valve

A new, specially-designed solenoid valve, produced and marketed by the Detroit Controls Div., American-Standard Corp., is now available for vending machines.

The unit, called S-25, features constant water flow and accurate delivery regardless of varying supply pressures, the firm reports.

Accurate delivery of a predetermined amount of water is available as a result of a unique flow control device built into the valve outlet connection. It has positive opening and closing at pressures from $2^1/_2$ to 200 psi, with flow capacities from $^1/_4$ to 6 gpm, for temperatures up to 180 F.

Precision Balancer

Aero Supply Mfg. Co. announces development of a new precision portable balancer for grinding wheels.

The new balancer is claimed to offer fast, accurate balancing of grinding wheels without removing the wheel from the grinder. Balancers for internal, external, centerless, and center grinding machines will be included in the line.

The balancer has been designed to achieve precision balance and return the machine to production in less than 30 minutes. Once the hub and wheel are in position, accurate balancing of the wheel is achieved in minutes by use of a set of three adjustable weights inserted in the hub, the firm explains.

The weights are infinitely adjustable and the two balance screws permit micrometer adjustment of the weight. Extensive vibration tests showed repeated accuracy within .000040 in. displacement (concentricity).

Pneumatic Rivet Setters

Fragile materials such as ceramics and plastics, can be successfully riveted with a minimum of breakage with pneumatic rivet setters introduced by Chicago Rivet & Machine Co.

The line includes single and multiple setters as well as machines for integration into automated operations. Air line pressure requirements are 50 to 60 lb. Controls are electric.

The firm says cushioned operation not only reduces breakage but also makes the machines suitable for fastening assemblies consisting of uneven material thicknesses.

Quick change hoppers with integral raceways permit setting of other rivets of smaller body diameter and within the maximum rivet length. Change over for different rivets takes only a few minutes and involves replacement of rivet hopper-raceway unit, driver jaws and anvil, the company states.

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Submersible Sump Pump

Deming Co. has announced the introduction of the firm's new Demersible sump pump.

The new pump is a submersible combining pump and motor in one compact, complete unit. The motor is totally sealed and oil filled in a cast iron case. It has a stainless steel shaft and impeller nut. The unit can be lowered quickly into a sump pit for temporary service or permanently installed for continuous service, the company states.

The pump's controls can be located in a convenient place. It is furnished with 30 ft of waterproof cable and motor lifting lugs. An extra large diaphragm is designed to prevent oil loss due to thermal expansion and contraction. The pump has a capacity from 15 gpm to 700 gpm.

It has a semi-open type impeller with a precision bore for perfect alignment. It is keyed for positive drive. Both pump and motor shafts are made of stainless steel.

Electric Hoist Cutoff

Fast-acting mechanical overload protection for the operator, load and the hoist itself, is now claimed to be available for the first time on any type of electric hoist.

Designed and built to fit any Wright Speedway Electric Hoist, the new overload cutoff unit, which is an integral part of the hoist frame, has been introduced by the Wright Hoist Div., American Chain & Cable Co.

According to the manufacturer the unit is calibrated and sealed at the factory so it can take rugged abuse up to the critical point of overload; then it instantaneously "breaks" the raising circuit of the hoist. This allows the load to be safely lowered to the floor and unhooked. Once this is performed, the raising circuit is automatically restored, the firm explains.

High Vacuum System

Kinney Mfg. Div., New York Air Brake Co., announces the first offering of a practical vacuum system that will attain pressures of 1×10^{-9} mm Hg or better within a chamber affording adequate space for production or extensive experimentation.

The stainless steel 12 in. diam by 18 in. high work chamber is equipped with two 2 in. diam windows, rotary motion and electrical feed-throughs. The work chamber is enclosed in a mild steel outer chamber which has two mating 2 in. observation ports and is fitted with heating elements, radiation shields and wrapped with water cooling coils.

The outer chamber is evacuated to the 10^{-5} range and the work chamber pumped to an ultimate pressure of 1×10^{-9} mm Hg.

Even the free flow of CO_2 from a cake of dry ice is difficult to control.

HOW TO RELATE FLOW, VOLUME AND PRESSURE

Shown above is a 24-inch, high-speed Rotovalve installed as a pressure control valve between the blowdown vessels and settling chamber of a Mach 5 wind tunnel operated by the Convair Division of General Dynamics Corporation at San Diego. The valve operates at 600 psig, 400° F., on a one-second, open-to-close cycle. Its rangeability is 150 to 1.

Perhaps you have a similar problem, involving flow, volume, pressure and time. Every special valve application requires the consideration of many questions, in order to relate all the factors that can influence a fluid control problem. This demands specialized engineering . . . the kind you get from Allis-Chalmers.

A-C Rotovalves may be your answer. Their full-line opening offers no obstruction to flow. They may be designed to give you extremely close control of closing time. Positive closure gives completely tight shutoff against either pressure or vacuum.

If you have a fluid control problem, A-C offers you a broad background of specialized valve engineering and application skills. To find out more about how we might assist you, contact your nearest A-C valve representative, or write Allis-Chalmers, Hydraulic Division, York, Pa.

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Rotovalves • Ball Valves • Butterfly Valves • Free-Discharge Valves

Hydraulic Turbines & Accessories • Pumps • Liquid Heaters

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CASH-ACME ... meeting pressure control needs for product design engineers everywhere

CASH-ACME SPECIAL BY-PASS VALVE HELPS AIR FORCE LICK ICE PROBLEM IN ARCTIC

The greatest potential "saboteur" at Strategic Air Force Command bases in the Arctic is ICE. That's why mobile de-icers are as highly prized as radar.

In perfecting modern de-icing equipment, air force designers received an invaluable assist from Cash-Acme engineers. Since ordinary valves and liquids are completely inoperative at 65° below zero, new methods were urgently needed. With the help of Cash-Acme Back Pressure Valve (Type FR) specially modified for this extremely rigorous job—a unique sprayer was developed for discharging ethylene glycol.

Using high pressure spray nozzles to thaw out iced-up areas, crewmen keep jet bombers and interceptors ready for instant take-off.

TYPE FR BACK PRESSURE VALVE
Ready for tough, exacting jobs anywhere. Automatically controls desired maximum pressure by maintaining a determined inlet pressure at valve and relieving into a low pressure line. Readily usable for all liquids and gases. Slight modifications make it useful as a differential pressure regulator. For Answers to Pressure Control Problems in Your Product.

A. W. CASH VALVE MFG. CORP.
666 East Wabash Ave., Decatur, Ill.

CASH ACME

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Masking Coating

A new protective coating, which will seal metal and stainless steel surfaces against the biting and cleaning effects of pickling and passivating, has been developed and now being marketed by Consolidated American Services, Inc.

The coating allows the machined surfaces and the other polished surfaces to be protected during the pickling and passivating operation, the firm reports. This material is also used by the plating industry.

The material, designated, CMS-N-202, is black in color. It can be applied by brushing on, with spray gun, stencilled on, dipped, or any other conventional method of application.

Control Valves

A full line of auto-manual control valves, designed for automatic interlocking of manually-controlled circuits or to permit manual operation of an automatically-operated system, is announced by Valvair Corp.

Used in interlocked circuits, the valve can prevent out-of-sequence or accidental manual actuation which otherwise might result in damage to the machine, the workpiece or injury to personnel, says the manufacturer. In normally-automatic circuits, the valve permits manual operation for machine set-up, or in emergencies.

For interlocking, a stock diaphragm end section is fitted to a standard Valvair body, with a knob, lever or other type manual control mounted on the opposite end. Manual operation of the valve is unrestricted until air is applied to the diaphragm end. Actuation of the diaphragm returns the valve and holds it in the status-quo position.

Fitted with a return spring, the valve functions automatically, actuated by any 3-way pilot valve, instrument or process control. With actuating pressure off, the valve can be operated manually.

The auto-manual valves, for use in air, oil, or vacuum service, are available with 2, 3, or 4-way valve bodies. Piped or open end exhausts are optional on 3 and 4-way valves, and any combination of Valvair end sections and mounting styles are offered. Port sizes range from 1/4 through 1 in. NPT and flow area through the valve is said to equal nominal pipe size.

FIGHT HEART DISEASE

GIVE HEART FUND

Did you know that

The Engineering Societies Library

can serve you by air mail and air parcel post? Over 170,000 engineering texts, and files of every worthwhile periodical are available for further research to meet your specific needs—patents, design, research, construction, and management problems. Charges cover only the cost of the services and represent but a fraction of the value you will receive.

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ME-7

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

New Micropitch

A New Diamond Micropitch, standard bushing chain manufactured by Diamond Chain Co., will soon be available from stock.

Diamond Micropitch combines high strength and high resistance to joint wear with minimum size and weight to permit large variety of shaft centers. Multiple shafts can be accurately timed because sprockets may engage both sides of the chain.

Sprockets and special attachments can be made to specifications.

Designers and users of electro mechanical equipment, communications devices, cameras, ordnance instrumentation equipment, instruments, radar, data processing machines, tape recorders, and many other applications can now use the dependable, extremely fine pitch bushing chain.

Available from stock in stainless or standard steel.

BUSINESS NOTES

To Add New Plant

American Pulley Co. has announced plans for a new building to house expanded operations of the company. Construction will start immediately.

American will erect a modern one-story building adjacent to its present facilities at 4200 Wissahickon Ave., Philadelphia. The new building which will be completed by fall is intended to help meet the increased demand for American's line of power transmission and materials handling equipment and to provide more space to handle a new product line which will be announced to the trade in the near future.

Research Center

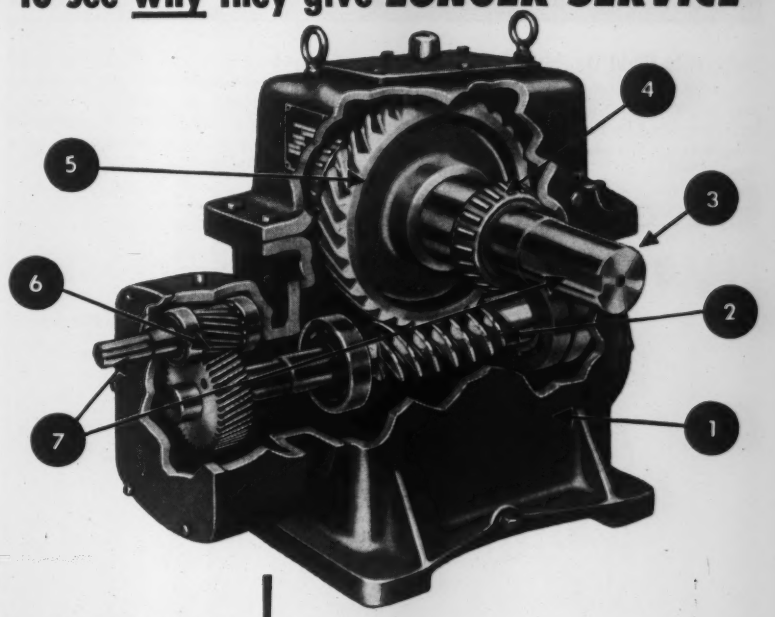
MPB Research Center, a building devoted principally to research and development, but also for new products manufacturing in the precision metal working field, has been announced by Miniature Precision Bearings, Inc., Keene, N. H.

The $500,000 facility, according to the company, will provide 40,000 sq ft of floor space. This space will be utilized by MPB engineers, technicians and manufacturing personnel to advance the state of bearing technology through new products, new applications, and product improvements. The company expects to begin occupying the new quarters by late summer of 1959.

Look Inside a Foote Bros.

ENCLOSED WORM GEAR DRIVE

to see why they give LONGER SERVICE



1 EXTRA STRONG CAST HOUSING
Provides rigid mounting and alignment of caps and bearings. Made of high quality cast iron.

2 PRECISION ALLOY STEEL WORM
Integral with oversize shaft. Carefully matched to worm gear for quiet, trouble-free service.

3 OVERSIZE OUTPUT SHAFT

4 HEAVY DUTY, EXTRA LARGE BEARINGS
Oversize bearings used throughout unit. Worm bearings are combination single row radial and angular contact ball bearings. Input shaft bearings are single row radial type.

5 WORM GEAR
Precision generated from uniform density, high hardness virgin bronze alloy casting. High load carrying capacity.

6 HEAT TREATED HELICAL GEARS
Shaved for full tooth contact. Pinion integral with input shaft. Gear locked in position on worm shaft extension.

7 Just one of 10 different types, in a wide range of sizes, ratios and shaft arrangements.

One look at the oversize bearings, larger shafts, precision made gearing and the sturdy housing of a Foote Bros. Hygrade Worm Gear Drive tells you that *this* is a workhorse unit that will stand up and deliver under the toughest conditions.

Notice the carefully balanced design . . . greater mass where it's needed . . . the elimination of weight when it contributes nothing to efficiency . . . strength and toughness at the right places . . . the correct gear alloys . . . the compact design, and above all, the simplicity and ruggedness of this unit.

When you know the *inside* story of Foote Bros. Hygrade Worm Gear Drives, you can understand why they have built a reputation for quality, dependability, and performance that is unmatched by others.

Write for Engineering Manual HGB. It contains complete information on Hygrade Enclosed Worm Gear Drives.

100 YEARS SERVING INDUSTRY 1859-1959

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4559 SOUTH WESTERN BOULEVARD • CHICAGO 9, ILLINOIS

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Coffeyville Plant Doubled

A plant expansion program, adding more than 13,000 sq ft of floor space, has recently been completed by Funk Mfg. Co. of Coffeyville, Kans. The plant now contains more than 23,000 sq ft.

The additional space will be used to enlarge the size of the assembly area, to provide an indoor, all-weather product testing area and to house numerous new machines the company has purchased, including an automatic gear-blanking machine.

WATER PRESSURE CONTROLLED

G-A *Cushioned*
Water Pressure Reducing Valve

Like the elephant, water pressure can be big trouble if not controlled. That's what the Golden-Anderson Pressure Reducing Valve does. This sensitive valve always delivers water at the same predetermined pressure . . . regardless of upstream variance. No need to fear water line damage from high initial pressures with this Golden-Anderson Valve on the job.

Write for Bulletin W-3A

GOLDEN ANDERSON Valve Specialty Company

1223 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

Opens Beaumont Facility

Clark Bros. Co., one of the Dresser Industries, has announced the opening of expanded facilities for packaging its line of field compressors.

Located at the Beaumont, Tex. plant of Ideco, Inc., another Dresser division, the new operation is designed to permit rapid delivery of Model CFA and CFB packaged field compressors in western and southwestern United States.

Pipe Companies Sold

Midwest Piping Co., St. Louis, has purchased from the Sparton Corp., the physical assets of two Sparton subsidiaries, Flori Pipe Co., St. Louis, and Houston Pipe & Steel, Inc., Houston.

The firm described the purchase as an initial step in Midwest's planning to extend and broaden the base of its nationwide operation in every phase of fabrication and erection of piping materials and systems for the utility, petroleum, and petrochemical industries.

LATEST CATALOGS

Hydraulic Packings

Sixteen pages of engineering data are contained in a brochure on homogeneous and fabric reinforced hydraulic packings issued by Crane Packing Co.

The information encompasses design, construction, sizes, applications, installation, proper usage and service and temperature factors for V-rings, U-cups, and piston cups. A single page insert on homogeneous wiper rings is also available. Text is accompanied by illustrations, engineering drawings and informative tables.

Inconel Tubing

The Inconel family of small tubing is described in a four-page technical bulletin published by Superior Tube Co.

Listed in the folder are the chemical composition, physical constants and mechanical properties of five materials in tubing form: Inconel, Inconel "X", Inconel "702", Ni-o-nel and Incoloy. All five are trade-marked materials of International Nickel Co. According to the folder, all five analyses are furnished as seamless tubing.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Selector Switches

Data Sheet 162 describes a new series of rotary selector switch assemblies that feature a cock-and-fire-actuating mechanism and non-tease circuitry, manufactured by Micro Switch Div., Minneapolis-Honeywell Regulator Co.

The 28AS series assemblies are for use on aircraft, electronic, and computer panels, and other areas where mounting surface is at a premium. They can be provided with 2 to 8 plastic enclosed single-pole double-throw basic switches.

Herringbone Gear Pumps

Bulletin G-1, published by Schutte and Koerting Co., describes the company's line of herringbone gear pumps.

The gear pumps are stocked in standard iron and steel construction in sizes from $^1/_2$ through 4 in. They are built in larger sizes up to 8 in. and in other materials on order. Cast steel, bronze, nodular iron, and stainless steel are used as required if justified by service conditions. Designs are available to pump at pressures up to 1000 psig, and to handle low viscosities or up to 10,000,000 SSU.

Large Tractors

Five standards for measuring big tractor value are described in "Five Yardsticks," an eight-page booklet, No. 33341, by Caterpillar Tractor Co.

Performance, dependability, matched equipment, serviceability and dealer organization are the five standards listed in the two-color brochure. These yardsticks are applied to tractors in the D8-D9 class.

Electromagnetic Pulley

Stearns Magnetic Products has announced the development of a newly-designed line of electromagnetic pulleys for removing tramp iron from belt-conveyed bulk materials.

The manufacturer states the pulley provides a simple, effective means of magnetic separation and protection in normal material handling conveyor processes without altering the present system. The unit will assure positive separation of ferrous materials at belt speeds up to 600 fpm, the company says.

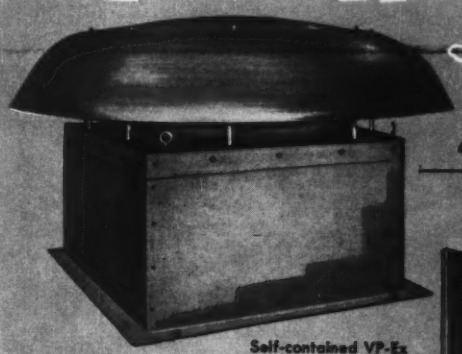
An eight-page bulletin explains the application of magnetic pulleys in modern process industries and outlines the principle of operation. Tables and formulas are given for selecting the right pulley size for normal separation, faster belt speeds or inclined conveyors.

Air Starting Motor

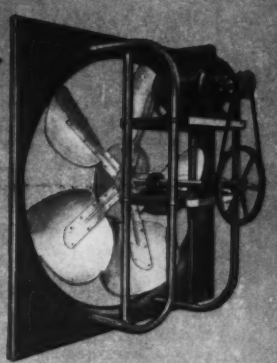
Ingersoll-Rand has prepared a 24-page bulletin containing case histories of air starting motor installations and information on how to select the proper air starting motor.

It provides specifications and mounting-dimension diagrams for two new motors —Size 3BM and 10BM—as well as for prior Sizes 5BM and 20BM. Drawings show piping arrangements for each size and a suggested hook-up for using the motors on vehicles.

VP-EX PROPELLER-TYPE
belted roof ventilator



Self-contained VP-Ex belted roof ventilator



Standard heavy-duty type belted propeller fan

The outstanding performance of the VP-Ex Belted Roof Ventilator is derived from insistence on quality at every step—from its galvanized construction through its complete industrial-type propeller fan. Capacities from 4450 CFM to 33900 CFM; also available in smaller direct drive sizes.

Send for Bulletin 582.

nyb THE NEW YORK BLOWER COMPANY

SALES OFFICES: 3161 S. SHIELDS AVENUE • CHICAGO 16

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

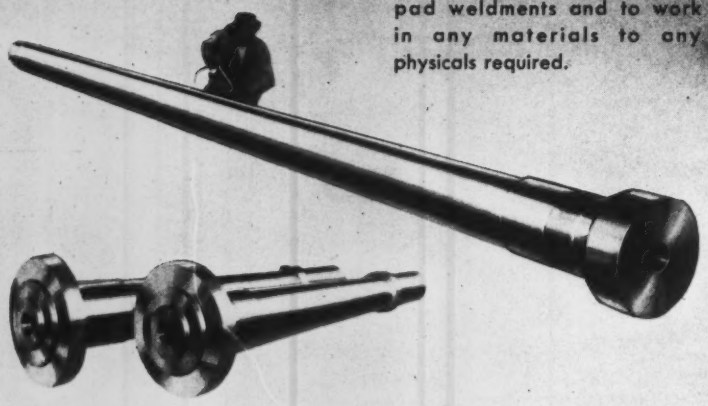
Underfeed Stoker

Catalog No. 401 issued by Detroit Stoker Co. gives data on double retort underfeed stokers built for heavy duty service in the intermediate size range for boilers of about 20,000 to 34,000 lb of steam per hour capacity.

The unit burns nut, pea and slack or crushed run of mine bituminous coals efficiently and without smoke, the firm reports.

PRECISION
BORED and HONED PARTS
by
American

If your deep bored and honed part is up to 16" I.D. and up to 40 ft. long, we are equipped to meet your exacting specifications. We have the tooling and the experienced skills to produce hollow parts to any internal or external finish desired. We are equipped to supply flanged or pad weldments and to work in any materials to any physicals required.



American's special boring and honing service is described in a 20 page brochure. Write for a copy.

AMERICAN HOLLOW BORING CO.

You can depend on American as a reliable source for precision bored and honed parts for your most exacting applications.

1058 West 20th Street • ERIE, PENNA.

Light Weight Piping

Four-way savings obtainable by using light weight carbon steel piping are outlined in Bulletin TT 942, available from Tube Turns Div., Chemetron Corp.

Dimensions are given for light weight welding fittings available in $^3/_4$ to 24-in. nominal pipe sizes and for the firm's 125-lb forged steel light weight taper face flanges. Advantages listed include lower cost than standard weight, lighter weight for shipping and handling, fabrication and erection savings, and increased flow efficiency.

Adjustable-Speed Drives

Adjustable-speed and drive control problems are discussed in a booklet produced by Cleveland Worm Gear's Speed Variator Div.

Designated Bulletin No. K-250, the booklet presents eight pages of applications along with methods and types of remote and automatic control, plus variable speed bedplate assemblies.

Condensation Pumps

A 12-page catalog describing four different types of vacuum return line condensation pumps for heating systems is announced by C. H. Wheeler Mfg. Co.

Horizontal and vertical models with standard and special capacities are described, with emphasis on such features as the needle-type, positive-action pilot valve, ease of alignment, positive-action, nonchattering discharge valve, flexible couplings, and the jet vacuum-producing unit.

Stainless Steel Wire

Stainless Steel Div., Jones & Laughlin Steel Corp., has published a 20-page manual of information on stainless steel wire, a new product line for the division.

Information on its use, its mechanical properties, and corrosion data are included in the manual. It also contains tables listing round wire weights, conversion of fractions to decimals and millimeters, and analyses of various types of stainless steels.

Gear, Fluid Drives

Information on what is described as the most extensive line of standardized gear-motors, motogears, and fluid drives available to industry has been combined into a 48-page book available from Link-Belt Co.

Book 2747 describes the functions of the various types of drives and provides selection data, dimensions, overhung load ratings and mountings. It also lists such accessories as couplings, backstops, and slide rails. A total of 45 new units has been added to the line.

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Solid Front Gages

Crosby Valve & Gage Co., has published a four-page catalog, No. 500SF, describing its recently introduced line of solid front pressure indicating and test gages.

The gages are housed in a rigid case with integrally cast front shield to protect personnel in the event of a blow-out. Overpressure conditions are relieved by the full nylon blow-out back, said to be a unique corrosion-proof, weather-proof feature of the Crosby-Ashton solid front gage.

Air Chucking

The cost and time saving advantages of air operated chucking systems are described in Bulletin PO-66D published by Cushman Chuck Co.

In addition to illustrations and a listing of the firm's line of standard air chucks and cylinders, considerable space has been devoted to a typical application with detailed installation procedure.

Temperature Control

A two-page brochure has been issued by Fenwal Inc. to describe its new transistorized thermistor controller, Series 535.

Specifications, available temperature sensing probes, and suggested applications for packaging, printing, synthetic fiber processing, and general industrial storage are included in the brochure. Also described are the principle of operation and available modifications.

Seamless Steel Tubing

Ohio Seamless Tube Div., Copperweld Steel Co. has issued a revised version of its 14-page tubing and facilities catalog.

The booklet describes carbon and alloy seamless steel tubing in mechanical, pressure, aircraft mechanical, and airframe grades. A three-page foldout flow chart illustrates major steps in seamless steel tube production. Contents also cover electric welded carbon steel tubing in mechanical and pressure grades, forging and fabricating operations, special tubular shapes.

Lubrication Equipment

Automatic, air-powered, and hand operated lubrication equipment for industrial plants is illustrated in a 16-page catalog published by Gray Co.

The new Powerflo catalog section D contains descriptions of air-powered pumps for handling centralized lubricating systems and Gun-Fil lubricators for automatic machine bearing lubrication. Fittings, hose, and accessories used in industrial lubrication are also described.

Packaging, Shipping Data

Signode Steel Strapping Co. has published a catalog of ideas for improving packaging and shipping methods in all industries.

The 48-page booklet covers strapping, tools, and equipment.

General Service Valves

Valves for general services are discussed in a 20-page bulletin, E-165, available from Everlasting Valve Co.

Types, typical services, construction, operating features are discussed. Drawings, photos and cutaways are included.

This high capacity Amplitrol "packaged" unit bolts directly to the hopper flange. Feeds to conveyors, crushers, screens, blenders, other process equipment.

"Feeder-Hopper Bottom Package" Reduces Design, Installation Costs!

For the first time a feeder is offered as part of a complete pre-engineered feeder-hopper bottom package. When you design with Carrier Amplitrol feeders, you merely design a hopper flange to bolt to the packaged unit. *This saves you both engineering design and installation costs!*

This preassembled packaged unit is built around the revolutionary new Amplitrol feeder — first mechanical vibrating feeder with variable, stepless control—and includes the hopper bottom, flanged hopper connection, skirt plates, regulating gate, isolation and suspension supports.

The feeder-hopper bottom unit is offered in two models—one for *high capacity* applications and one for *maximum control.*

Amplitrol's exclusive long-stroke drive handles higher capacities by automatically compensating for headload. This allows larger hopper openings, reduces bridging and hang-up. The simple, fast-responding pneumatic control system operates manually or in automatic response to any standard process instrumentation.

Send for new Bulletin No. 591 describing Amplitrol "package" in detail. Carrier Conveyor Corporation, 223 North Jackson Street, Louisville, Kentucky.

CARRIER

~~NATURAL-FREQUENCY~~

VIBRATING EQUIPMENT

Engineering Specialists in Vibrating Equipment

CONVEY ● FEED
DEWATER ● SCREEN
COOL ● AGGLOMERATE
DRY ● SCALP ● COAT
DISTRIBUTE ● ELEVATE
● FLATTEN BAGS

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Oil-Immersed Contactor

Construction and design features of Allis-Chalmers unmounted oil-immersed a-c contactors , Type 426, are described in a new bulletin released by the company.

Rated at 400 amp, 5 kv, 50 mva in a small tank which can be mounted in the new small size front access starter, the oil-immersed unit is designed for operation in hazardous, corrosive or dusty atmospheres. It is designed to handle 2500-hp squirrel cage motors at 4800 v and unity power synchronous motors up to 3000 hp, 4800 v.

low air pressure can
SABOTAGE
your plant production

Curtis protects... against it!

Air hammers, drills, sand blasts may be working... but are they working at peak efficiency?
With the right Curtis compressor on the job, you can be sure of an adequate and dependable supply of compressed air at the proper pressure.

PRESSURE-UP YOUR TOOLS

The sealed, precision-built Curtis AIR COMPRESSOR delivers all the power your tools can use.

- Two-stage, air-cooled . . . 1 thru 50 H.P.
- Single-stage, air-cooled . . . ¼ thru 5 H.P.
- Timken bearings; pressure lubrication.

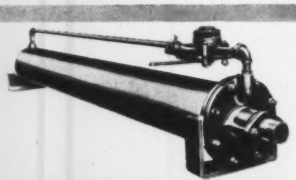
Tank-mounted compressors, ¼ thru 20 H.P. (1 to 95 cu. ft.).
Simple and base-mounted, ¼ thru 50 H.P. (1 to 217 cu. ft.).

PENDANT AIR HOISTS

LIFT, LOWER... PUSH or PULL... UP TO 10 TONS

Movement smoother than human hands. Precise control. And precision Curtis manufacturing assures efficiency, long life; trouble-free operation.

C-65



BRACKETED AIR CYLINDERS
For horizontal or vertical mounting

Curtis
MANUFACTURING COMPANY
PNEUMATIC DIVISION
Write Dept. 44,
ST. LOUIS 20, MISSOURI

Electronic Weighing

Streeter-Amet Co. has reprinted a 12-page booklet on industrial weighing through electronics.

The booklet explains the history and development of electronic weighing, theory of operation, instrumentation, economic considerations, and general data for instrumentation and remote recording.

Gear Checker

A technical bulletin, No. 607, covering its new low-cost, compact, and versatile gear checker designed for roll checking the most widely used range of gear sizes is now available from Michigan Tool Co. Using master gears rotating on a spindle in a replaceable precision bushing, the checker will indicate rolling errors on a dial gage in increments of 0.0005 in.

Sprockets, Chain Drives

Cullman Wheel Co. has published a comprehensive, illustrated engineering and stock catalog on sprockets and chain drives.

The 88-page catalog covers 1300 different stock sprockets and various types of roller chains, and gives technical data and chain drive engineering information.

Multi-Pointer Indicator

A compact group of individual miniature vertical gage units called Mini-line multipoint indicators are illustrated in new four-page Product Specification P11-1 issued by Bailey Meter Co.

Details of pointer movement, $3^1/_4$ in. scale design, and optional internal illumination are provided.

Chemical Feeder

Proportioneers Div. B-I-F Industries, Inc. announces a bulletin describing its low capacity chemical feeder for low cost controlled feeding of hypochlorite or other water treatment chemicals into small water systems.

The Model 19131 chemical feeder is an air of water-operated diaphragm type proportioning feeder. It operates on 110 v, 60 cycle a-c. Complete kit, ready to install, includes feeder, instructions, suction and discharge tubing, foot valve, injector nozzle, spare parts. The firm says a see-thru molded plastic reagent head enables visible check of diaphragm and check valve action while pump is operating. Pumping rates are adjustable from 1.9 to 22.8 gal per 24 hours. Recommended maximum delivery is 1.5 cc per stroke against 70 psi discharge pressure.

SAVE DRAFTING TIME WITH

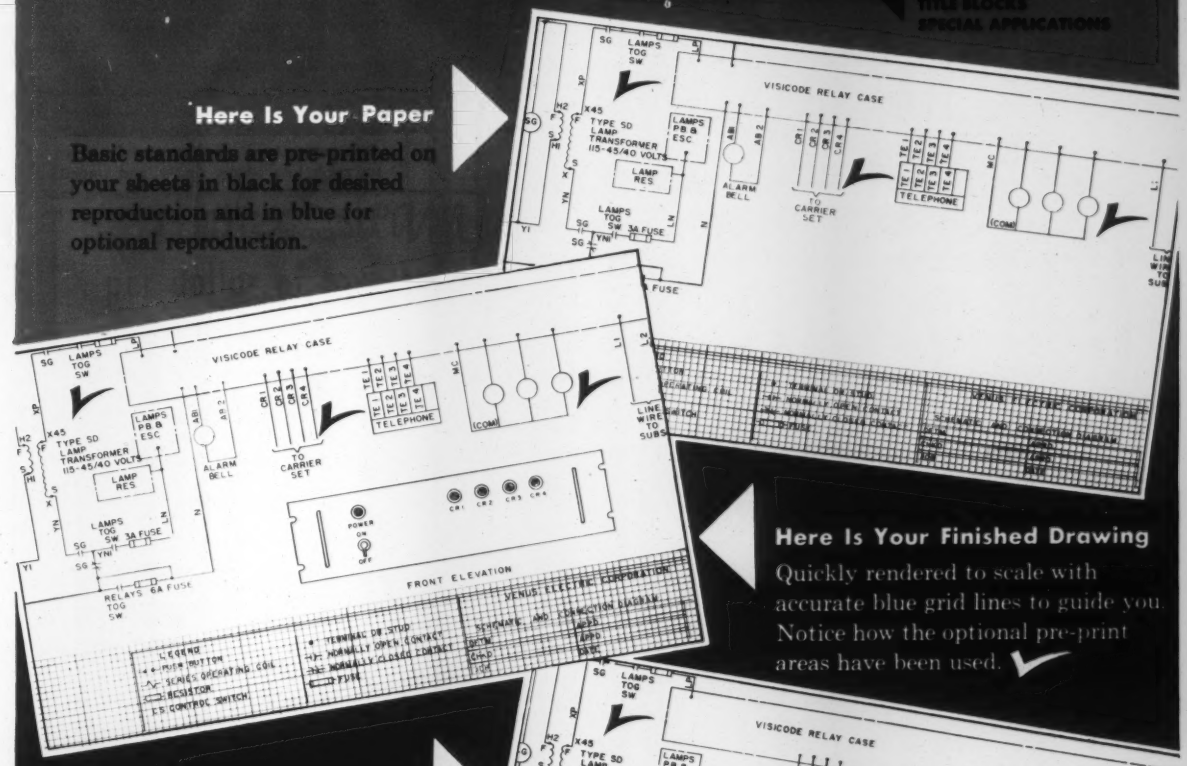
CLEARPRINT® "FADE-OUT PRE-PRINT" FORMS

t.m. t.m.

PRE-PRINTED
TYPICAL DETAILS
BASIC STANDARDS
BILLS OF MATERIALS
TITLE BLOCKS
SPECIAL APPLICATIONS

Here Is Your Paper

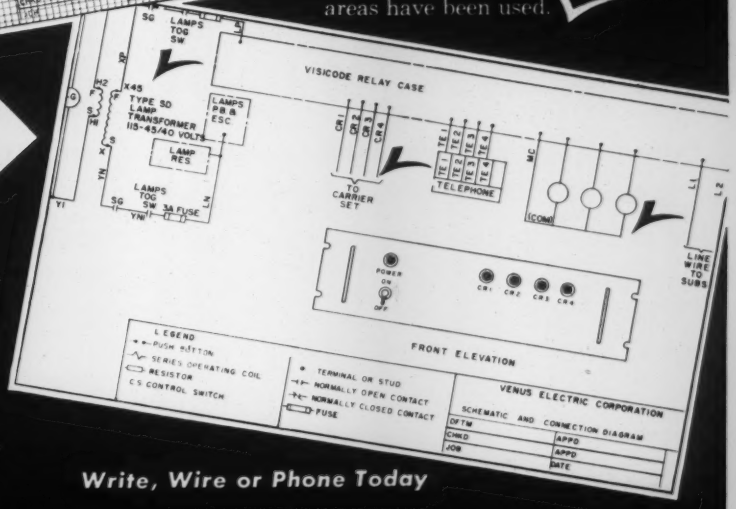
Basic standards are pre-printed on your sheets in black for desired reproduction and in blue for optional reproduction.



Here Is Your Finished Drawing

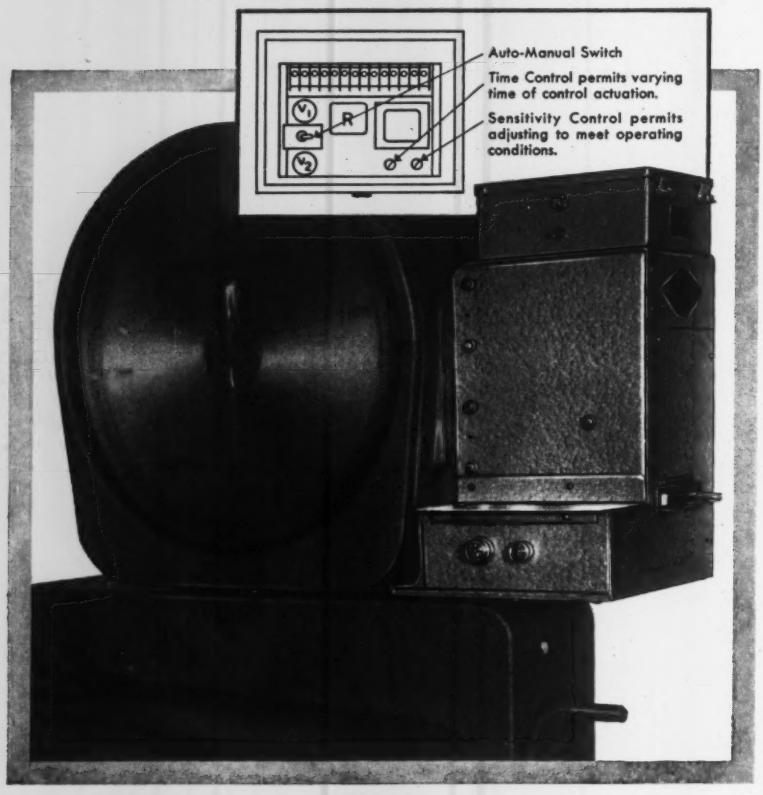
Quickly rendered to scale with accurate blue grid lines to guide you. Notice how the optional pre-print areas have been used.

Here Is Your Finished Print



Write, Wire or Phone Today

NEW Fairbanks-Morse Electronic Weight Detector


Auto-Manual Switch
Time Control permits varying time of control actuation.
Sensitivity Control permits adjusting to meet operating conditions.

Prevents incorrect weighing . . . stops costly errors!

With the new Electronic Weight Detector, true weight of any load can be automatically obtained and recorded without need of a weighman. Where a weighman is used, it is impossible for him to record incorrect weights or start a sequence at the wrong time. When desired, a flip of the switch can disengage the Weight Detector entirely from the system. *This is the first fully-reliable control of its kind available in the scale industry.*

To completely automate your weighing—to be sure that your weights are correct—to protect yourself by completely policing your entire weighing operation—contact your nearby Fairbanks-Morse Field Engineer, or write directly to Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois for complete information.

See Sweet's Plant Engineering File for full line of F-M Scales

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

SCALES • PUMPS • DIESEL, DUAL FUEL AND GAS ENGINES • ELECTRIC MOTORS
GENERATORS • COMPRESSORS • MAGNETOS • HOME WATER SYSTEMS

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Bandpass Filters

An eight-page brochure, describing a line of miniature ceramic i-f bandpass filters which provide low impedance, increased selectivity, greater stability with respect to time and temperature, high Q and low cost is available from Clevite Electronic Components Div., Clevite Corp.

The brochure lists bandpass characteristics and includes attenuation curves for narrow and wideband applications in military and commercial equipment. It discusses insertion loss, shape factor and impedance transformation of the new ceramic ladder filters. Bandpass filter applications in transistor circuits are also included.

Power Lubrication

Details on recent developments in power lubrication systems are featured in a catalog published by Lincoln Engineering Co.

It gives information on new, power-operated, centralized lubrication systems, including those recently adopted as optional factory-installed service accessories by leading manufacturers of automobiles, truck-trailers, and industrial machinery. The book covers description and functions of manual, mechanical and electric automatic controls, together with photographs of the various types of installations, diagrammatic illustrations, and information on ordering.

Alloy Wrought Iron

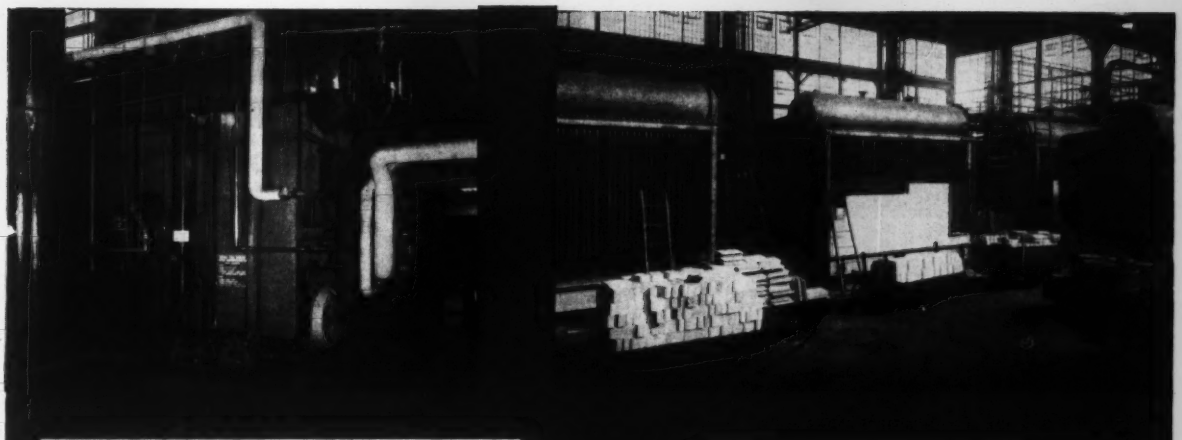
Mn wrought iron, a specialty alloy wrought iron containing approximately 1 per cent manganese, is described in an eight-page booklet available from A. M. Byers Co.

The booklet contains charts showing the new metal's improved impact resistance at sub-zero temperatures. Data on corrosion is also included. It also discusses working properties, availability, and Mn's suitability in low temperature services where the possibility of brittle failure poses engineering and design problems.

Seal Design Manual

A comprehensive manual which includes engineering data, design relationships and standard size data on the long stroke, deep convolution constant area seals, has been issued by the Bellofram Corp.

The 20-page design catalog presents a basic description of the unique seal along with typical applications and uses as well as installation drawings, methods of attachment, installation techniques and standard dimensions. In addition to presenting a detailed analysis on four basic classes of seals, the reference work tabulates construction materials of standard elastomer compounds as well as standard and non-standard fabrics.

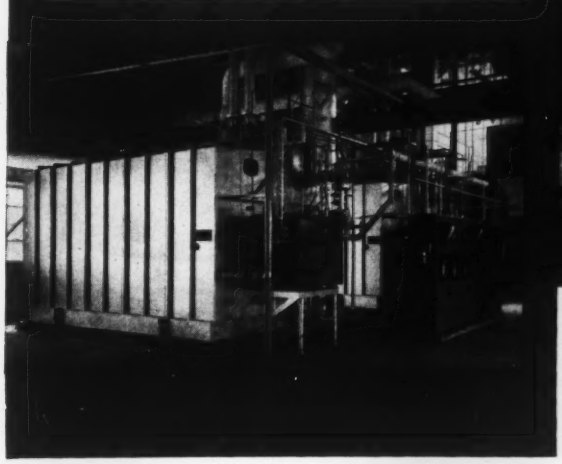


More Steam per dollar of investment with Vogt

PACKAGE WATER TUBE BOILERS

Completely shop fabricated, with burners, controls and accessories installed before shipment.

Placed on a suitable foundation, only fuel, water, breeching and steam connections need to be made to place unit in operation. Vogt Package boilers are available in oil and/or gas fired types in standard pressures of 175, 250 and 375 pounds per square inch gage.



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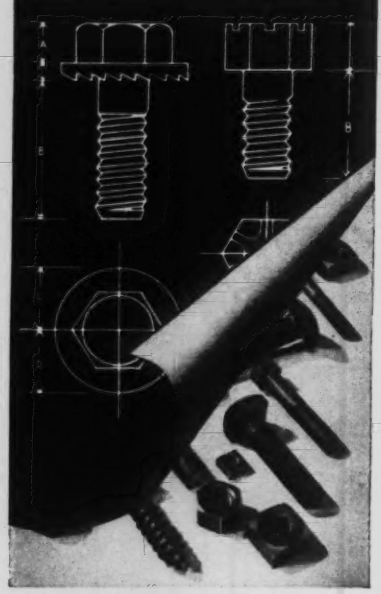

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NEW EQUIPMENT
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Portable Switches

Portable switches are the subject of new literature released by the Electrical Products Div., Joy Mfg. Co.

Featured is the new pendant push-button station, a weathertight, corrosion-proof design completely insulated and encased in Hycar, an improved synthetic rubber compound, and listed as available in 4-, 6-, and 8-button styles. Both front and back sections as well as an interior view of the station, showing the switch well, water seals, and the micro-type positive switches in proper position, are shown in the booklet.

Condensation Pumps

Condensation pumps for steam heating systems are described in a catalog offered by C. H. Wheeler Mfg. Co.

Features of the flexibly-coupled and close-coupled models are listed in detail. Installation diagrams are shown, and ratings, capacities, pressure, and speeds are given for six different types of condensation pumps. Construction and design of pump receivers and the pumps themselves are detailed. Specifications for Types NCR, MR, U (underground) E, EC, and ECR are also included.

Plate, Face Cams

An eight-page catalog, No. 900, by Ferguson Machine Corp. of Indiana introduces standard and semi-standard plate and face cams.

Nearly one hundred standard units are listed by stroke, timing, and load rating. Availability of other cams precision milled from standard blanks, as well as physical design, manufacturing processes, application, and installation are also discussed. Graphs showing relationship between stroke, minimum movement time, and size of cam blank are provided to simplify cam selection.

Finishing Processing

A 30-page catalog on precision mechanical finishing and automatic finishing processes is available from the Roto-Finish Co.

The catalog outlines in detail the various types of finishing and abrading processes such as grinding, deburring, descaling, and polishing. It also explains how radii can be broken and the fatigue resistance of metal parts strengthened through mass production finishing techniques. Included are illustrations and detailed descriptions of the various conventional models as well as the firm's automatic finishing machine, and the newly developed Vibratron which employs a vibratory abrasive action. Dimensions, capacities, and recommended usage of the various types of equipment are included.

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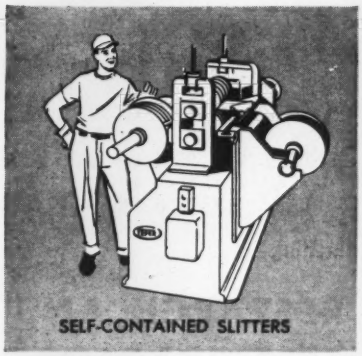

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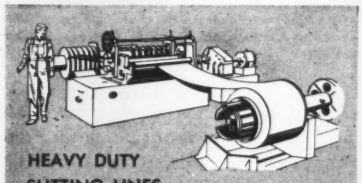

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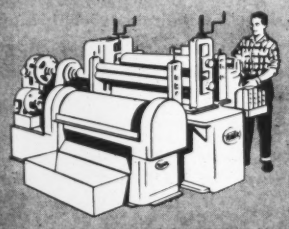

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Gas-Fired Intake Units

Gas-fired intake units for supplying tempered make-up air to replace air removed by industrial exhaust systems are described in Bulletin A-115 issued by Hartzell Propeller Fan Co.

The bulletin cites fuel costs figures to prove economy advantages of direct-fired units which achieve nearly 100 per cent combustion efficiency by burning natural or propane gas in a line-of-flame burner directly in the air stream. The series includes 2, 4, and 6 million Btu per hr, with air volumes of 25, 50, and 75 thousand cfm.

Colorimetric Analyzers

Bulletin 1156-1 covering its automatic colorimetric analyzers has been published by Milton Roy Co.

It describes the industrial instruments available for colorimetric determinations of trace quantities of substances dissolved in liquid process streams. It gives details on analyzers for dissolved silica, dissolved oxygen, and total water hardness. Schematic diagrams are included as well as descriptions of the pneumatic programmer, unique sample cells, and devices for measuring reagent.

Electronic Signaling Controller

A four-page catalog describing and listing specifications for its new electronic signaling controller is now available from Thermo Electric Co.

Designed for two-position (off-on) control, this potentiometer type instrument is said by the company to be used for accurate and automatic control of industrial processes, furnaces, ovens, molding machines, casting machines, pickling tanks, and extruders. The controller may be used with any sensing element that generates a d-c signal. Corrective action occurs almost simultaneously with deviation of the input signal from the preset control point.

Bushings, Washers

A supplement to its Bulletin DU-458A dealing with DU dry bushings and thrust washers has been published by United States Gasket Co., Plastics Div. of Garlock Packing Co. The firm is the sole domestic source of the British-developed Teflon-lead high performance dry bearing material.

The supplement, designated DU-458A, includes new information on dry bushings and thrust washers and alternate installation tolerances and instructions for fitting bushings. Also new in this supplement is a complete list of DU thrust washers currently available. This list includes part numbers and dimensions of each as well as instructions for fitting thrust washers.

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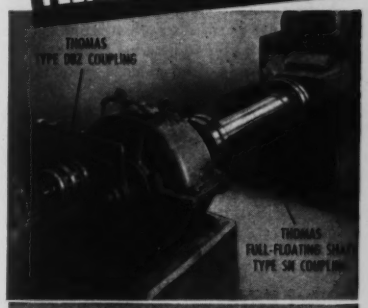

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Filter Elements

A four-page catalog, No. BFD-48, describing nine basic filter element materials for air, gas, and liquid filtering requirements, is now available from Bendix Filter Div., Bendix Aviation Corp.

The various elements are discussed and illustrated with cross-section and microscopic photographs. Also discussed and illustrated are the methods of rating and testing filter assemblies, as well as the firm's clean-room facility for assuring ultra-clean metallic filters on a production basis.

Control Valve

Model 300 three and four-way control valve is described in a four-page leaflet offered by W. H. Nicholson and Co.

Nine illustrations, including wash drawings of cut-away views and several diagrams, explain operating principle and design features. Specifications for the several sizes carried in stock are set forth in a chart. Text describes the materials used, maintenance features, throttling characteristics.

Building Panel

How Alply, a unique insulating building panel, can open up new dimensions for builders and manufacturers, is presented in a 24-page brochure offered by Aluminum Company of America.

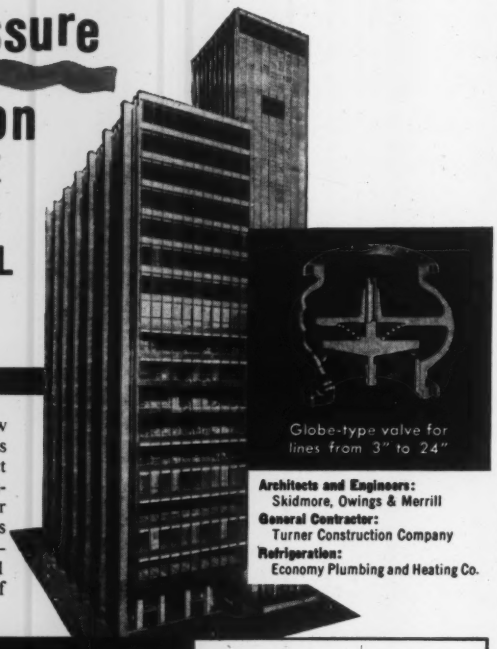
The panel, which consists of expanded plastic beads sandwiched between sheets of aluminum, is said to offer less costly and heretofore impossible simplification in the design and construction of appliances, homes, buildings, trailers, and a host of other applications.

Fittings, Flanges

Tubular Products Div., Babcock & Wilcox Co., has issued a 12-page booklet, FB-78, as a guide to material selection of carbon, alloy and stainless steel welding fittings and flanges.

The booklet covers specifications and analyses, effects of alloying elements, mechanical properties and arc welding procedures, as well as general catalog information.

surge pressure protection with SILENCE for the *Dramatic* INLAND STEEL BUILDING CHICAGO, ILL.



Globe-type valve for lines from 3" to 24"

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By operating instantly when flow reversal starts or when flow is zero *Silent Check Valves* protect against damage from surge pressures . . . eliminate water hammer in this new 18-story stainless structure. *Write for Bulletins*—No. 654 on the Valves; No. 851 on Cause, Effect and Control of Water Hammer.

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Looking for latest available data on types, sizes, purposes and facilities of research and test reactors? Then consult the book entitled,

RESEARCH AND TEST REACTORS

Vol. 2, of Nuclear Reactor Plant Data.

Here will be found specific information on fifty-three research reactors located in the United States and forty-two reactors situated in Canada, South America, Western Europe, Asia and Australia, which was furnished by responsible persons associated with the respective projects, and which includes as many of the following details and technical data as were available.

General: Reactor Location and Type. Owner, Operator, Designer, Constructor. Cost of Reactor Facility. Operating Staff. Annual Operating Cost. Status. Design Power. Normal Operating Power, Power Density, and Specific Power. Operating Schedule. Principal Use of Reactor. To Whom Available for Research? **Fuel:** Normal Fresh Fuel Loading. Total Fuel Inventory. Expected Average Burnup Before Reprocessing. Fluid Fuel. Solid Fuel. Method of Refueling. **Reactor:** Over-All Active Core Dimensions. Core-Containing Vessel Dimensions, Materials and Mean Operating Pressure and Temperature. Moderator. Reflector Thermal Shield. Biological Shield. Reactor Control. **Primary Coolant:** Fluid. Circulation. Heat Dissipation Method. Average Core Heat Flux. Ratio of Maximum to Average Heat Flux. Means of Purification. **Nuclear Data:** Fuel Loading. Fluxes. Reactivity Coefficients. Burnable Poisons. **Research Facilities.**

Data collected on each reactor are presented on a separate three-page form, the latter having been specially designed to facilitate their use.

Additionally, there are diagrams of reactor facilities, notes on special features, and other supplementary material.

Published, March 1959, 304 pages. 8½" x 11". $7.50 a copy, 20% discount to ASME members

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 west 39th St., New York 18, N. Y.

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

World-Wide Guide

The 1959 edition of Dresser Industries' world-wide guide to equipment and technical services has been published and is being distributed to executives in the oil, gas, chemical, electronic, and general industries.

The 68-page book is illustrated and provides reference to the many products and services supplied by the Dresser group of companies throughout the world. Convenient lists of Dresser representatives and their addresses in various countries are also included.

Water Control System

Advantages, principle of operation, and typical diagrammatic drawings of Bailey Meter Co. three-element feed water control systems appear in new, eight-page bulletin, No. 530.

Installation photographs are presented along with chart reproductions showing constant drum level under varying load conditions.

Self-Threading Nuts

An eight-page bulletin gives data on line of Palnut Company's self-threading nuts which form their own threads while tightening on studs of any malleable materials, including zinc and aluminum die-cast; also on rods, wire, and pins of steel, aluminum, brass or plastic.

The booklet includes engineering and assembly data, torque-tensile factors, advantages compared with threaded studs, nuts and push-type fasteners, dimensions, and typical applications.

Nickel-Copper Wire

A revised edition of Technical Bulletin T-3, containing the latest basic technical data on nickel-clad copper wire, has been published by Riverside-Alloy Metal Div., H. K. Porter Co. Two charts are incorporated into the folder to show the mechanical and electrical properties of the bi-metal. The revised technical bulletin also includes photographs of typical applications.

Heat Exchangers

A new edition of its booklet on design and cost comparison of heat exchangers using Trufin, has been announced by Wolverine Tube, Div. of Calumet & Hecla, Inc.

The 19-page catalog explains where Trufin, the integral finned tube should be used, how fins affect the design of heat exchangers and fouling factors, and a comparison of this and bare tube exchanger costs. Also included are conversion charts for various alloys.

Check Valves

A two-page circular, No. 588, describing check valves, has been published by the Lunkenheimer Co.

The circular illustrates and lists, with specifications, some of the many types of check valves in the firm's line—bronze, iron, and steel for boiler feed lines for air, water, and steam lines; and for controlling chemical and gaseous fluids.

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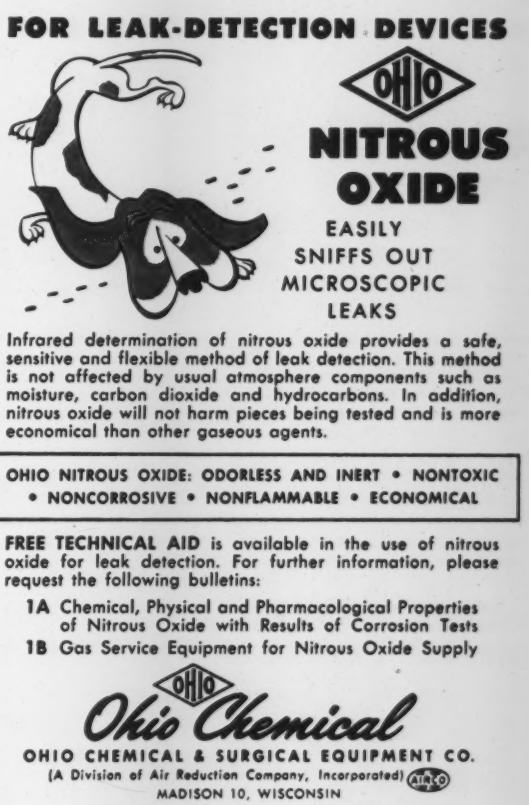
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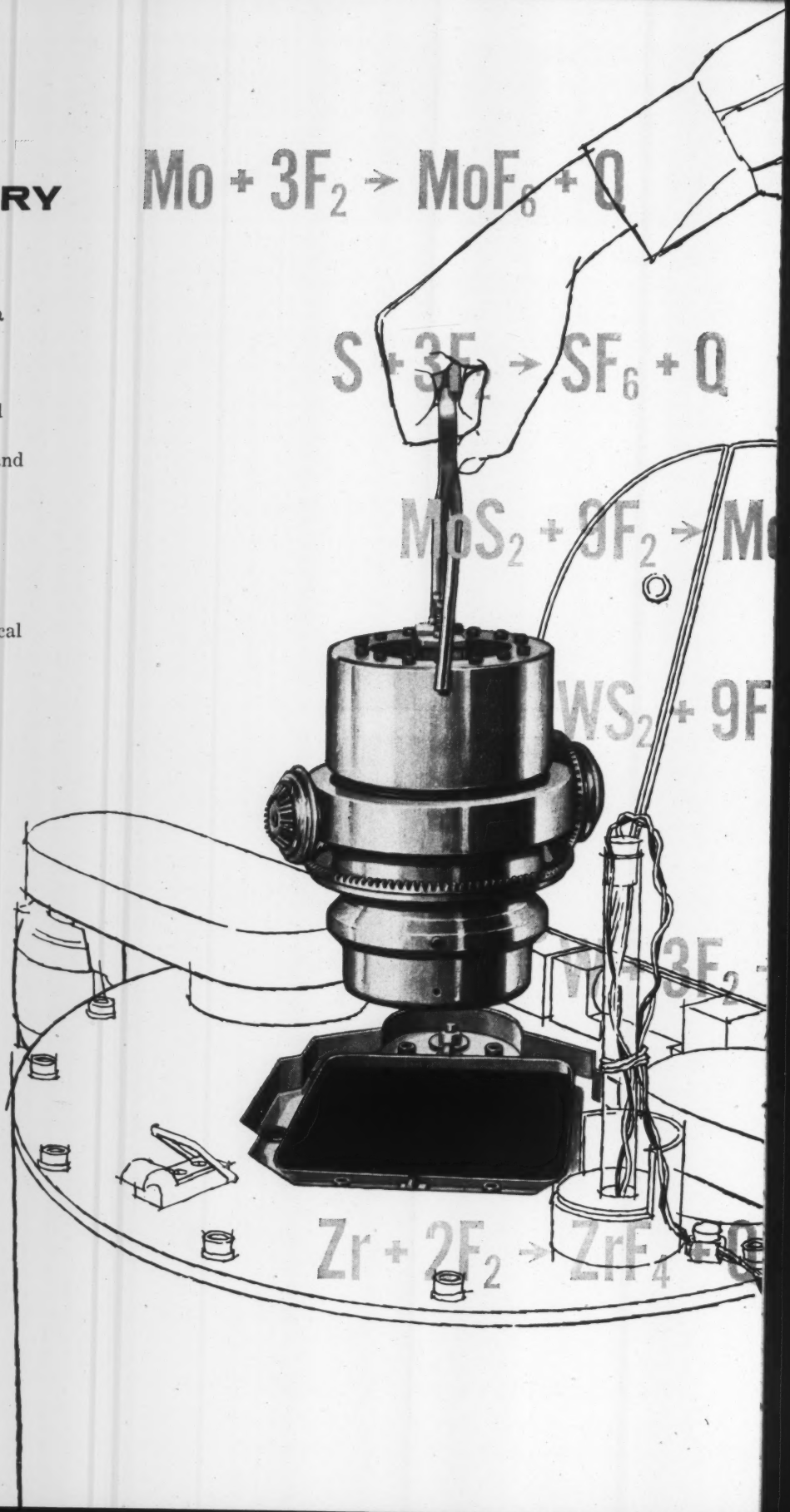
FLUORINE BOMB CALORIMETRY

Fluorine bomb calorimetry has been considered by many a thermochemist as he vainly struggled to react a stubborn compound with oxygen. However, the extreme chemical reactivity of fluorine presents difficult problems in handling and containment. Recently at Argonne, thermochemists have collaborated with scientists skilled in the techniques of fluorine chemistry to make fluorine bomb calorimetry a reality. Important thermochemical data is now being obtained on substances not amenable to conventional oxidation bomb studies. Many of the compounds which are used in high temperature chemistry because of their resistance to oxidation will be studied with this promising new thermochemical tool.



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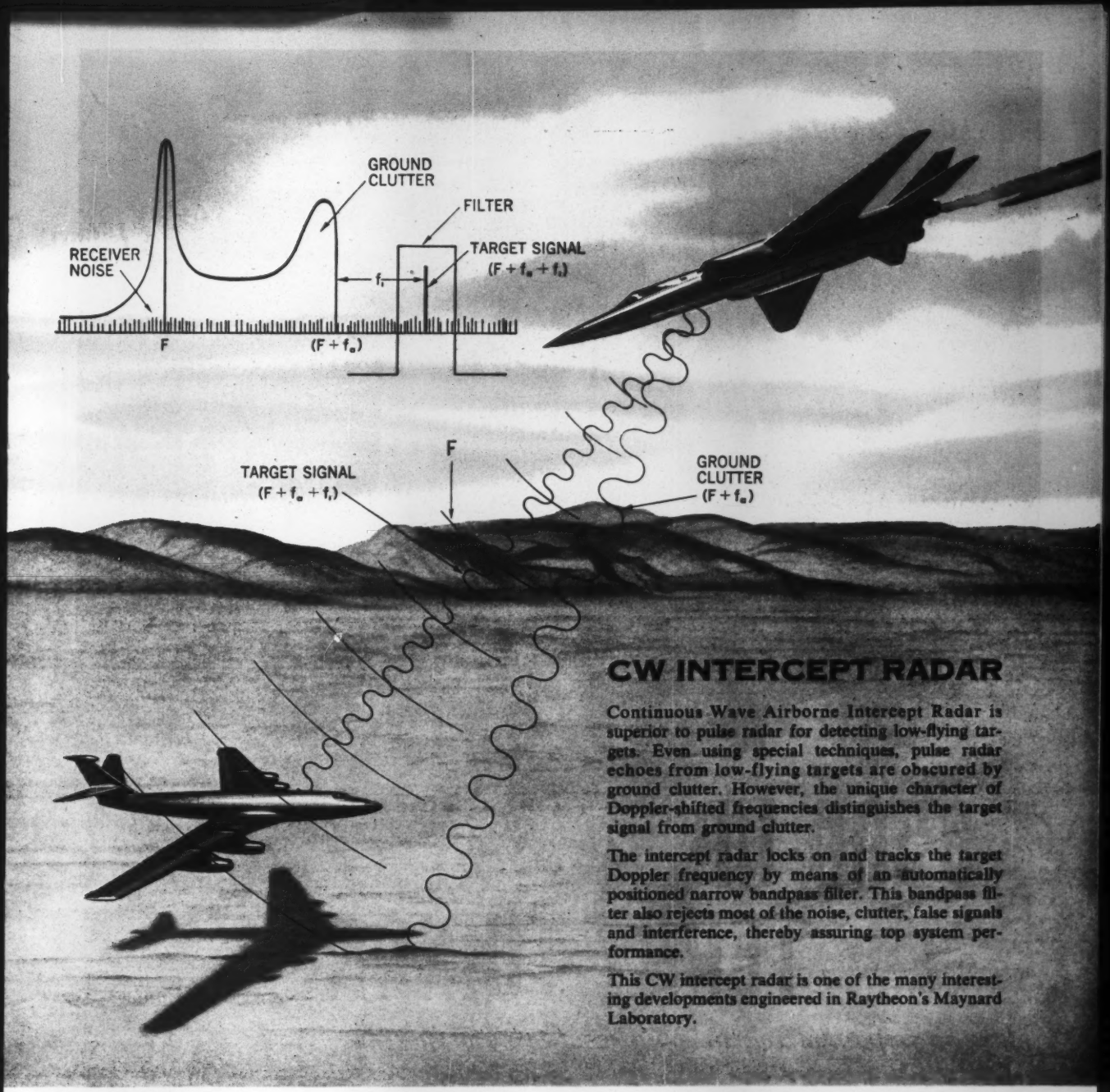

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Continuous Wave Airborne Intercept Radar is superior to pulse radar for detecting low-flying targets. Even using special techniques, pulse radar echoes from low-flying targets are obscured by ground clutter. However, the unique character of Doppler-shifted frequencies distinguishes the target signal from ground clutter.

The intercept radar locks on and tracks the target Doppler frequency by means of an automatically positioned narrow bandpass filter. This bandpass filter also rejects most of the noise, clutter, false signals and interference, thereby assuring top system performance.

This CW intercept radar is one of the many interesting developments engineered in Raytheon's Maynard Laboratory.

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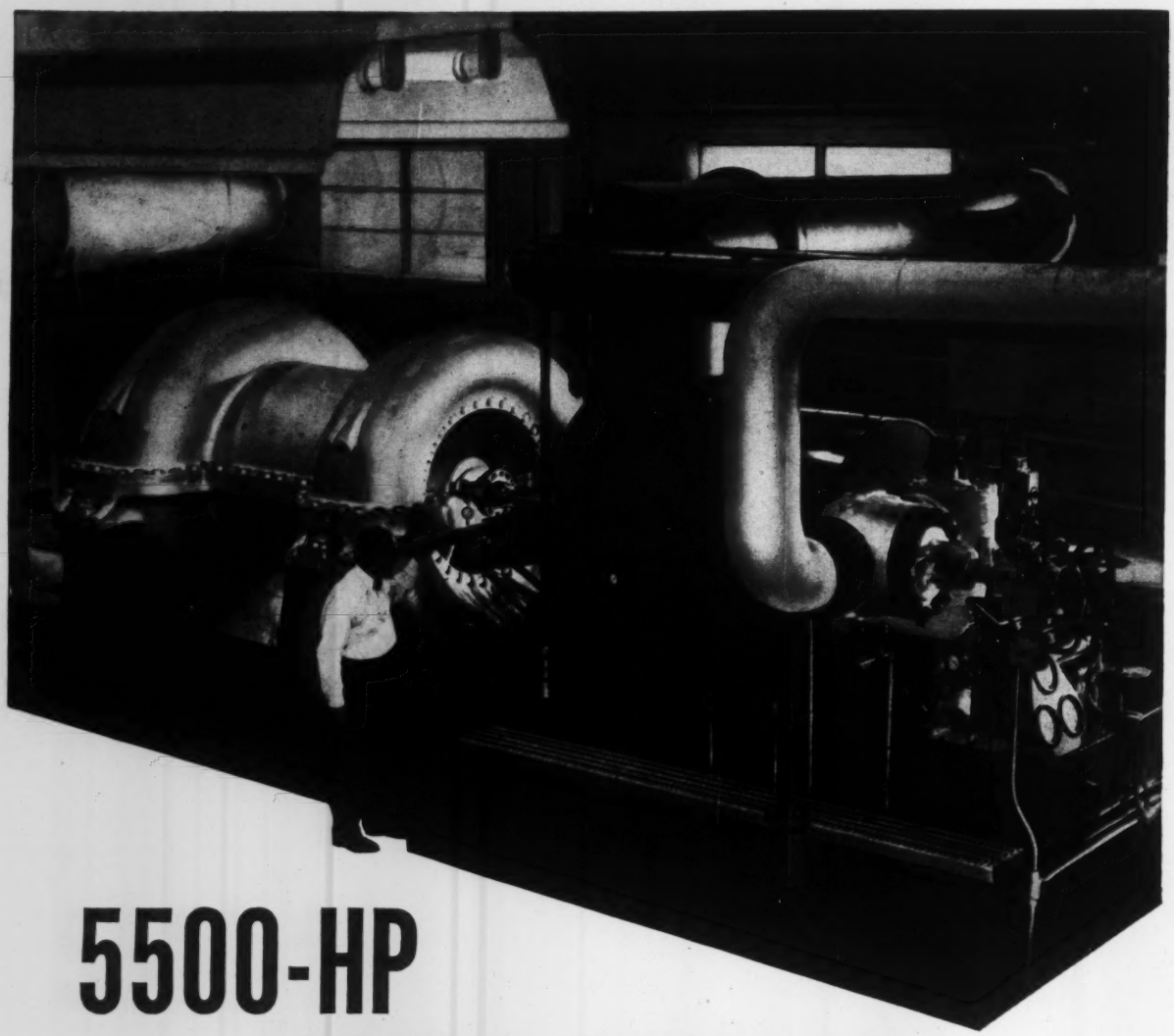

5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of bulletin S-146.

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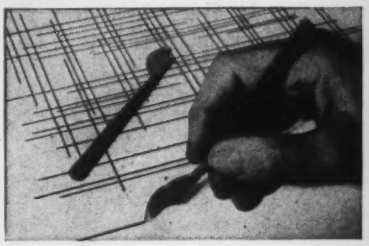
It may be that some of these products have escaped your attention (after all, we offer something over 8000 items). That's why we suggest you pay a visit to your K&E dealer whenever you can. It's a liberal education on what's new – as well as what's tried and true – in drafting equipment.

You'll find many products like these which can be highly useful in your work . . .

K&E "Quick Set" Bow Compass

The most remarkable feature of this compass is the speed and ease with which you can change settings–from diameters of 12 inches to 1/16 inch. With one hand, you can increase or decrease radii instantly and exactly. To go from small to larger radius, just press a spring release, and the legs will expand automatically. Stop approximately where you want, and make precise adjustments with a micrometer screw. To go from large to small, simply squeeze the legs of the compass together, then adjust precisely.

The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.



Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large ink supply – draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

An important feature of K&E Marathon Ruling Pens is that they will *not leak*. They can be laid on the work surface without risk of ink flowing out. That means you can fill several pens of different widths, use them as freely as you'd use pencils. They're easy to clean, too.

K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch – or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon *Wide Line* Ruling Pens come in line widths of .030 and .060 inch.

Leroy® Height and Slant Control Scriber

A versatile new Leroy scriber is now available which greatly expands the variety of lettering possible from a standard Leroy template.

Now, with the new Height and Slant Control Scriber (3237-12), you can form characters from vertical to slanting at any angle up to 45° forward. You can vary height from 60% to 150% of the size of letters on the template used. The width of letters remains the same.

Combinations of height and slant can be set quickly and easily. You just loosen the knob, move the scriber arm to the desired combination of height and slant, and tighten. That's all there is to it.

Stop in to see your nearest K&E dealer and ask to see these three products–small, perhaps, but mighty handy in the drafting room. Or drop us a line by mailing the coupon below . . .

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1913

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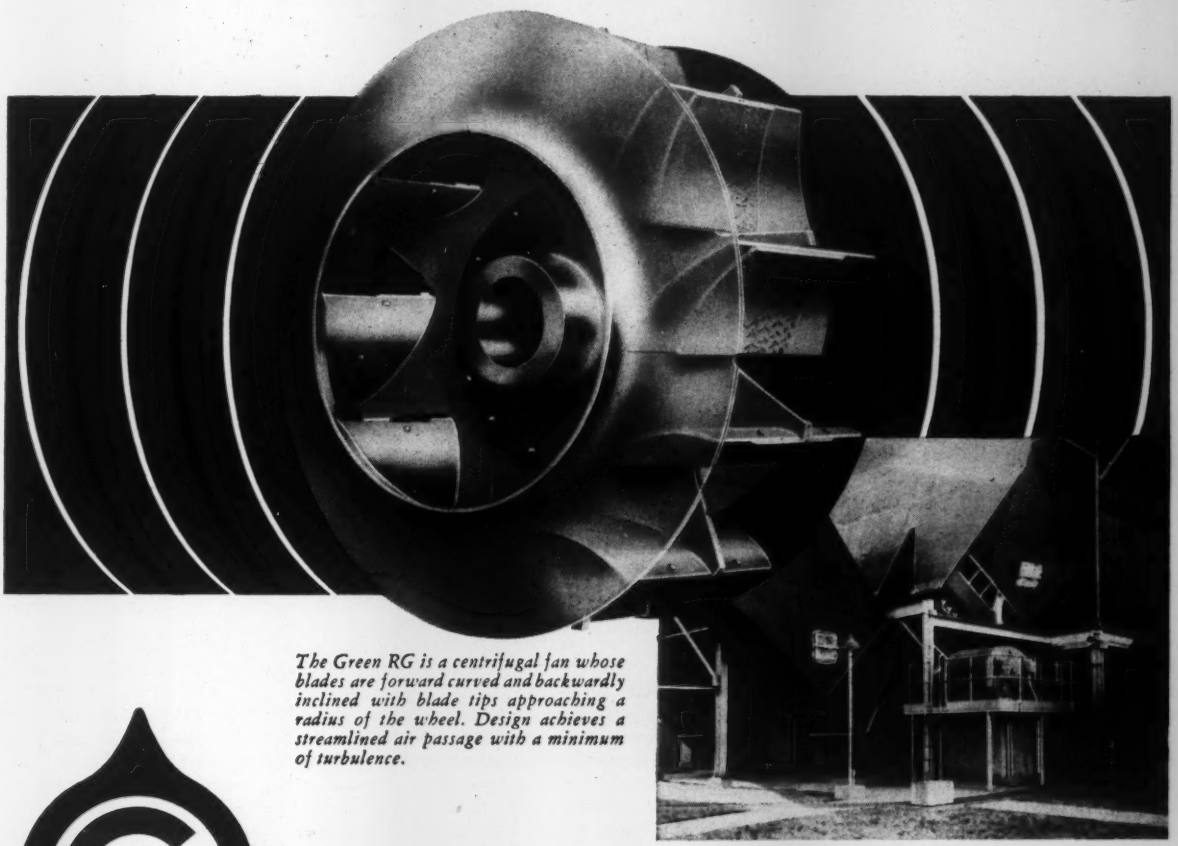

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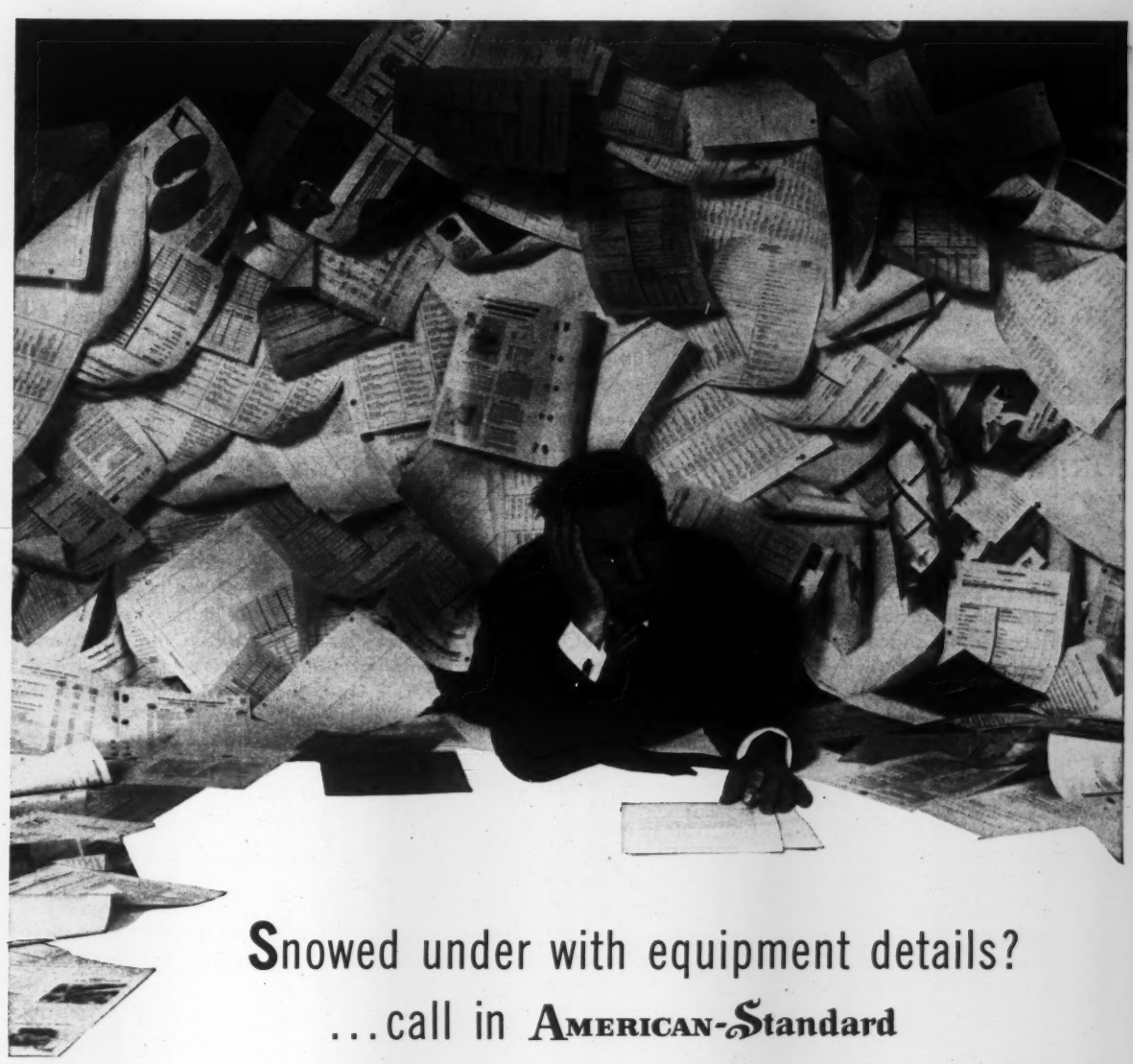

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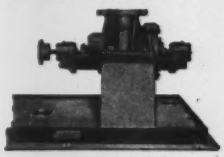

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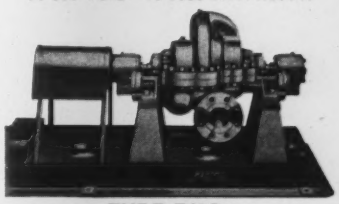

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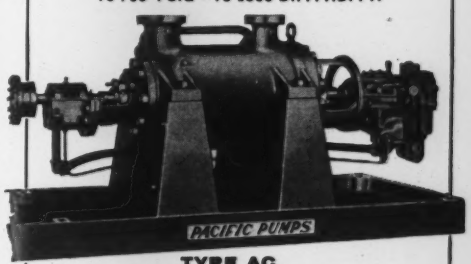

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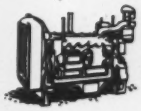

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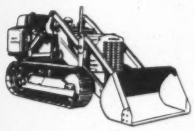

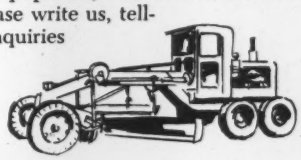

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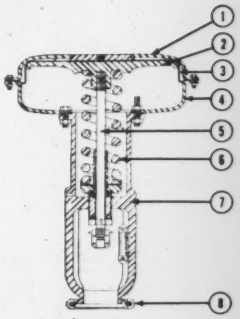

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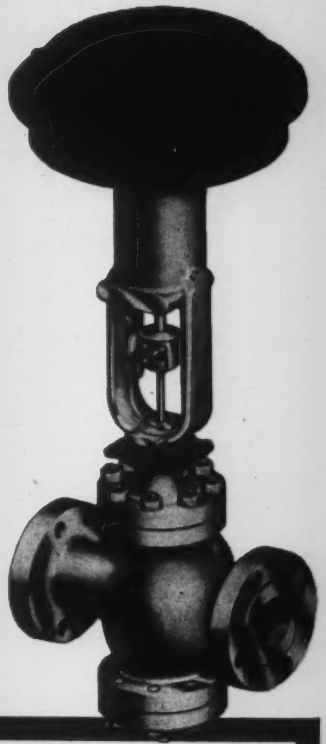

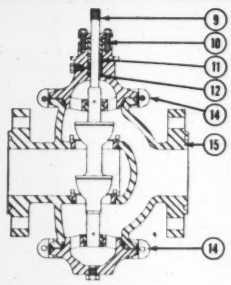

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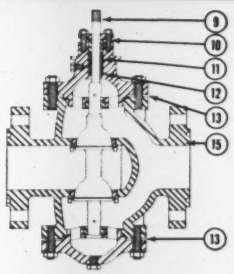

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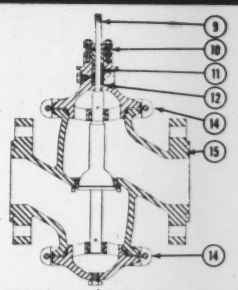

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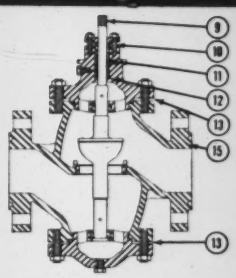

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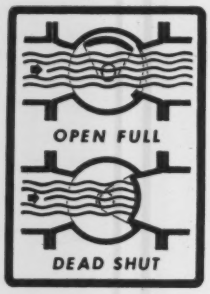

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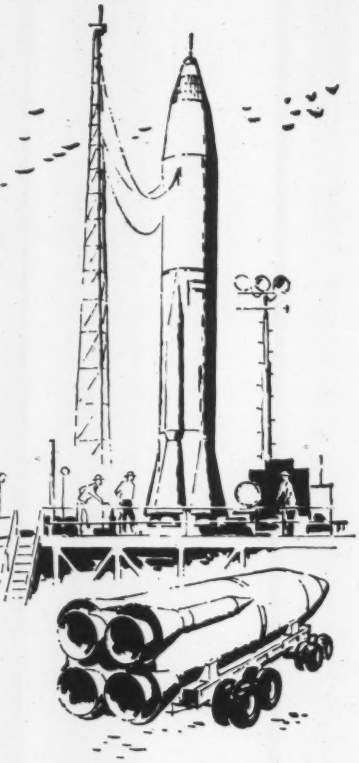
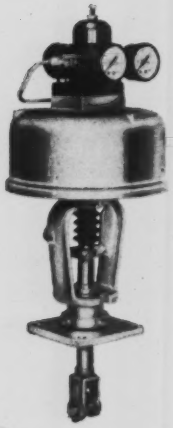
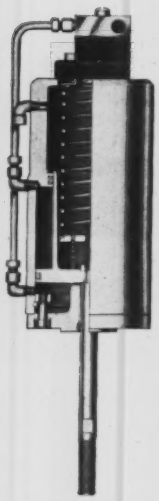




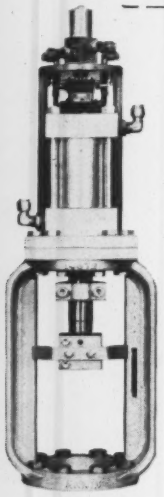
1542 & 1544 SERIES DOMOTOR POWERED ACTUATORS

Two types, "Direct Thrust" (illustrated) or "Lever" units are available for any application requiring accurate positioning in response to a pneumatic signal, such as butterfly valves, dampers, turbines and engine governors. Guaranteed positioning accuracy of better than 0.001" per inch of stroke over the complete range of piston travel is combined with a smooth operating action that provides an accurate, stable output force.



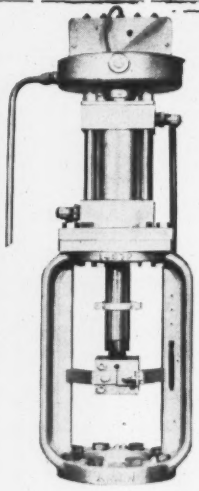
600 SERIES STROKE POSITIONING ACTUATORS

Offered primarily for the control of variable speed drives, rheostats, pumps and cams, as well as control valves, with strokes up to 6 inches and forces up to 2510 pounds of thrust. Compact and rugged, for easy mounting on existing equipment. May be operated from a standard 3-15 psi instrument signal, with a positional accuracy within 0.001" per inch of stroke.



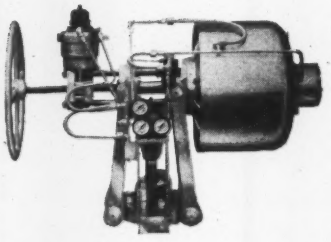
10,000 SERIES PNEUMATIC-HYDRAULIC ACTUATORS

For valves requiring strokes to 6 inches and thrusts to 100,000 lbs. Furnished on body assemblies where process conditions require very fine valve response, hi-speed and stability. Operate on 1500 psi oil supply system from any common instrument air signal.



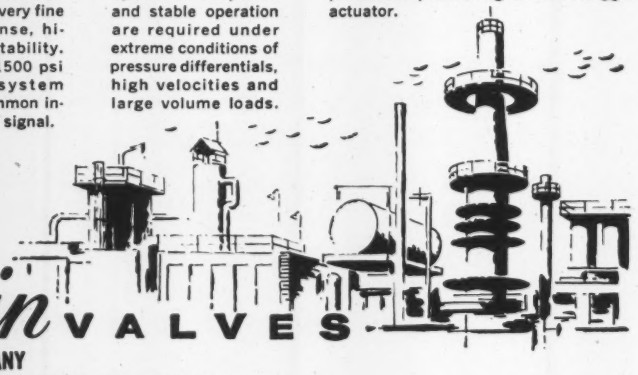
20,000 SERIES ELECTRO-HYDRAULIC ACTUATORS

Provide a means of converting an electrical signal to a powerful hydraulic positioning force, where high speed of response and stable operation are required under extreme conditions of pressure differentials, high velocities and large volume loads.



TOGGLE ACTUATORS

For process requirements where the unbalanced forces are extremely high, or where large through-puts are required. Three types are offered: pneumatic positioning, pneumatic on-off, and manual control, all embodying the toggle actuator; or a manual control arrangement can be combined with the pneumatic positioning or on-off toggle actuator.



Annin VALVES

THE ANNIN COMPANY
1040 S. Vail Avenue, Montebello, California

Write for Bulletin 1236-ST

OPPORTUNITIES

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.00 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $40.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

MECHANICAL ENGINEERS

Creative engineers . . . to translate development ideas into practical mechanical equipment for chemical R&D laboratory pilot plants involving a wide field of endeavor. Opportunity to develop non-routine assignments from conception through startup. BS/ME with 3-7 years' experience.

- Career opportunities
- Relocation allowance
- Extensive benefit program

Please send complete resume to Personnel Department

American Machine & Foundry Company

689 Hope St.—Springdale, Connecticut

EQUAL JOB OPPORTUNITY for All Qualified Applicants

AMF

PROFESSIONAL PERSONNEL REQUISITION

CONTROLS ENGINEERS

Marquardt's Controls and Accessories Division has established a position of leadership in the field of power system controls. Developing controls with high reliability; fast, precision response and extreme environmental capabilities provides challenge to creative engineers. If you have appropriate education and experience, investigate these job opportunities.

CONTROLS DESIGN—To create components for pneumatic and hydraulic control systems. Work ranges from simple piston actuators to complex speed computing devices. All designed for high sensitivity, fast response, extreme environmental conditions and light weight. Should be experienced in machine design and have an understanding of basic design analysis.

CONTROLS ANALYSIS—To investigate aircraft and missile control problems through the application of analysis methods in mechanics and dynamics, heat transfer, compressible flow, and servomechanisms. Position offers opportunity for creative engineering.

CONTROLS DEVELOPMENT—Opportunity to create workable controls components. Must have a "feel" for hardware and desire to undertake broad engineering responsibility. Opportunity to solve "on-the-spot" engineering problems utilizing pneumatic and hydraulic control analysis techniques.

For additional information, please write:

Mr. Floyd E. Hargiss, Manager
Professional Personnel, Dept.
Marquardt Corporation
16555 Saticoy Street
Van Nuys, California

THE Marquardt CORPORATION

Van Nuys & Pomona, California—Ogden, Utah
Subsidiary: Cooper Development Corp., Monrovia, Calif.

MECHANICAL ENGINEER

Graduate with 3-5 years' experience for position in Central Results Section of an upstate New York utility. Applicant must have a thorough knowledge and interest in thermodynamics, instrumention and controls, basic power plant cycles, thermal efficiency and good analytical ability. Work includes development of incremental cost data. Opportunity for creative thinking. Salary open. Liberal benefits. Send resume and general salary requirements.

Address CA-6720, care of "Mechanical Engineering."

CHIEF ENGINEER

A successful machine tool building company is seeking a Chief Engineer with administrative as well as designing experience. This company is one of the leaders in the industry. An excellent opportunity for a young engineering executive who wants to be part of a growth company. Send complete information to:

Address CA-6722, care of "Mechanical Engineering."

PETROLEUM PRODUCTION RESEARCH

Ph.D.—Physical Chemists, Physicists, Chemical Engineers, Petroleum Engineers, and Mechanical Engineers. 0 to 3 years' experience—fundamental and applied research in hydraulics, petrophysics, surface chemistry, reaction kinetics, and photoelasticity.

New facilities, suburban location, expanding organization, liberal publication policy, generous employee benefits, salaries commensurate with qualifications.

Please apply by letter, giving details of your training and experience, by writing to CA-6707, care of "Mechanical Engineering."

CREATIVE ENGINEERS

• Nuclear Reactor • Ceramics • Instrument and Control

Sanderson & Porter is engaged in the design and development of a high temperature, gas cycle Pebble Bed Reactor for the Atomic Energy Commission. Our New York office has superior positions open for engineers experienced in the following areas:

• Reactor Engineers—core and system nuclear analysis; shielding and hazards; design; test and operation of nuclear reactors.

• Ceramist—research and development of ceramic fuel elements.

• Instrument and Control Engineers—test and power reactor systems.

If you are interested and qualified, please write, sending complete resume, to Personnel Manager.

SANDERSON & PORTER
72 Wall Street, New York 5, N. Y.

Expanding the Frontiers of Space Technology in

ELECTRO-MECHANICAL DESIGN

■ Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. As systems manager for such projects as the Navy POLARIS FBM; DISCOVERER Satellite; Army KINGFISHER; Air Force Q-5, X-7 and X-17, the Division is heavily engaged in all phases of design and packaging.

ENGINEERS AND SCIENTISTS

If you are experienced in electro-mechanical design or packaging with specific knowledge of electronic packaging; wiring design; harness assembly; ignition and separation systems design or auxiliary power systems design, we invite your inquiry.

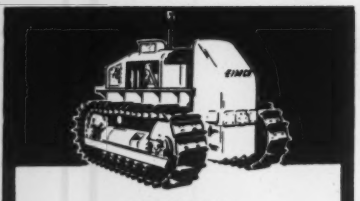
Write: Research and Development Staff, Dept. G-40, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII



MECHANICAL DESIGN ENGINEERS

Earthmoving experience, with successful record in design and development of heavy mechanical equipment, crawler tractors, bulldozers, winches and tractor attachments.

Work includes layout and design of heavy machinery for construction and mining.

Permanent positions open, for those qualified, with one of the nation's fastest growing heavy machinery manufacturers.

Location — Salt Lake City, Utah — in the mountain West, where you can breathe clean air, and drive from home to work in less than 20 minutes.

Send Complete Information and photograph to Dept. SXB

THE EIMCO CORPORATION

P. O. Box 300, Salt Lake City 10, Utah

MECHANICAL ENGINEERS

The Equipment Engineering Section of the West Virginia Pulp and Paper Company has immediate openings for Mechanical Engineers at their Research and Development Laboratories located at Covington, Virginia.

JUNIOR PROJECT ENGINEERS

Requires degree in mechanical engineering with or without experience. Age to 30.

SENIOR PROJECT ENGINEERS

Requires degree in mechanical engineering and experience in the machinery field or the paper industry. Age to 35.

These positions require versatility, creativity, and a high degree of mechanical ability to do responsible project engineering work. Working field: Paper converting and finishing machinery. Willingness to travel between plants is essential.

Salaries open.

Send complete résumé in confidence to—

Research Director
WEST VIRGINIA PULP AND PAPER COMPANY
Covington, Virginia

MECHANICAL OR CHEMICAL ENGINEERS

Research and development positions open with rapidly growing manufacturer of fuel injectors and spray nozzles.

RESEARCH ENGINEER: Prefer graduate engineer with 2–5 years' experience. Position involves nozzle design, evaluation, and data analysis. Familiarity with fluid flow, liquid atomization, and fuel technology desirable.

PROJECT ENGINEERS: Require graduate engineers with 2–5 years' experience to design and develop special fuel injection nozzles for rockets and aircraft gas-turbine engines. Desire background in product design, including drawings and specifications related to the manufacture of small precision parts to satisfy exacting performance requirements, and familiarity with fluid flow and flow metering, combustion, and physical properties of liquids.

ASSISTANT PROJECT ENGINEER: Graduate engineer with 0–2 years' experience to assist Project Engineer in design and development of fuel injectors for aircraft gas-turbine engines. Background similar to that of Project Engineer.

DELAVAN MANUFACTURING COMPANY
811 Fourth St., West Des Moines, Iowa
Attn: Mr. K. B. Luskin

ANALYTICAL ENGINEERS

career opportunities with an expanding facility in New England . . .

Requirements: BS in Mechanical Engineering or AE degree, 2-5 years experience in one or more of the following: 1) small turbo-machinery (compressor, turbines, fans) 2) lightweight heat exchangers 3) thermodynamic cycle analysis 4) air conditioning, air and vapor cycle refrigeration.

Duties: Work includes both applied theoretical and experimental analysis starting with initial design and continuing through prototype. Involves performance computation defining configurations of components and complete systems to meet specifications. Opportunity to utilize IBM 704 and 705 for complex methods of analysis.

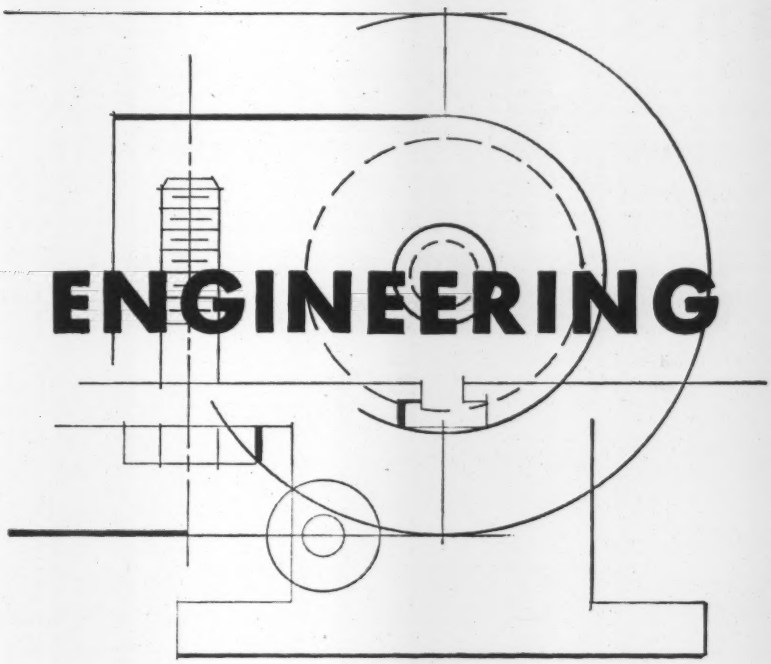
Join a technical group whose facilities and background knowledge are unrivalled in the industry. Your talents will be employed in the development of advanced concepts, and also in internal consulting work on problems encountered by the Design and Development Engineering Groups.

Very pleasant urban or suburban living conditions . . . opportunity for tuition-paid post graduate study . . . generous relocation allowance.

This Division of United Aircraft is now actively engaged in product diversification and development of jet aircraft equipment, ground support equipment and missile components.

Reply to Mr. A. J. Fehlber
Technical Employment Supervisor

HAMILTON STANDARD
Div. of
UNITED AIRCRAFT CORPORATION
441 Bradley Field Rd.
Windsor Locks, Conn.



ENGINEERING

At Los Alamos, the many-faceted field of engineering offers inspiration to skilled, imaginative professionals. Fascinating design and development projects in chemical, metallurgical, electrical and mechanical engineering are a vital part of the Laboratory's diversified research program. And engineering is just one of the many scientific activities in which far-seeing men and women find a challenge at the Laboratory of the future.

For employment information, write to: Personnel Director
Division 59-66

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

ENGINEERS—SCIENTISTS

Seek and Find Daring New Goals and Rewards with General Electric's Growing

FLIGHT PROPULSION DIVISION* IN CINCINNATI

*(*formerly Aircraft Gas Turbine Division, recently renamed to match its expanding product goals.)*

Our engineers and scientists enjoy the daily challenge of new and stimulating technical problems in the largest number of advanced propulsion system projects in our history. Men with imagination and ideas are needed as Managers and Specialists in:

. . . . high Mach powerplants using high energy fuels (Jet Engine Dept.)

. . . . commercial jet powerplants (Commercial Engine Operation)

. . . . exotic propulsion systems for rockets and space vehicles using plasma and ion power sources (Flight Propulsion Laboratory Dept.)

. . . . developing production techniques for unusual materials and design configurations (Production Engine Dept.)

Advancement opportunities are multiplied—

nearly 50% of our professional people earn promotion every year. Our engineering staff has more than doubled since 1955.

● ***LOOK INTO NEW POSITIONS NOW OPEN IN OUR 4 DEPARTMENTS IN CINCINNATI FOR Engineers and Scientists experienced in:***

Controls Mechanical Design
Jet Engine Aero Design
Quality Control Engineering
Compressor Design & Development
Mechanical Design Reliability
Test Systems Development
. . . . and many others.

(U. S. Citzenship Required)

For further information on the opportunities that will let you use your talents better, send your resume to D. Mark Peters, Bldg. **100**, *Dept.* **41**-*MG*

FLIGHT PROPULSION DIVISION
GENERAL ELECTRIC
Cincinnati, Ohio

Engineers & Metallurgists in

Cryogenics

This integrated growth company is foremost in the development, design, manufacture, construction and operation of plants for the low-temperature production of pure liquefied gases, missile fuels, tonnage oxygen,—and separation of complex mixtures of low molecular weight gases for the chemical, petroleum, metallurgical and steel industries.

These positions have been created in the expansion of our Engineering and Development activities. Each offers a challenging opportunity for professional participation in technical and scientific areas in both commercial and defense programs.

- **DESIGN ENGINEER . . .**
  Seeks ME with progressively responsible assignments in piping, vessels and general plant design in chemical, refinery or low-temperature fields. Knowledge of ASA PIPING CODE required, as well as experience directing draftsmen. Other design openings available for men with background in process equipment and/or recent ME degree men who rated in top third scholastically and are interested in piping, vessel and instrument design.
- **PROCESS ENGINEER . . .**
  Unusual opening for recent ChE to work in Chief Engineer's office to begin training in process work in Cryogenics. Must be top-flight student to qualify.
- **METALLURGICAL ENGINEER . . .**
  Organize, initiate and investigate program directed toward improvement of existing metallurgical processes or evaluation of new processes. Conduct laboratory test and follow through with steel mills. Open hearth or electric furnace background helpful. Also opening for BS or MS in metallurgy if ranked top third scholastically.
- **JUNIOR ENGINEERS . . .**
  Limited openings for highly selective recent ChE graduates who attained excellent college records and wish to undertake creative development work in field of Cryogenics.

Reply in confidence and detail to Donald Blackmore, Technical Personnel Manager

Air Products ...INCORPORATED

P.O. Box 538 Allentown, Pa.

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Challenging positions are available in research for men with B.S. to M.S. degrees in Mechanical Engineering, Chemical Engineering, or Aeronautical Engineering with experience in the fields of rocket propulsion, ballistics, and case design.

We offer you an opportunity to use your initiative and creative ability in an atmosphere conducive to accomplishment. These positions afford association with some of the leading engineers in this field.

Excellent employee benefits including liberal vacation policy and tuition free graduate study. Please send resume to:

E. P. Bloch
ARMOUR RESEARCH FOUNDATION of Illinois Institute of Technology
10 West 35th Street
Chicago 16, Illinois

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(Research, Product Design and Development)

VALVES for high pressure-temperature services including nuclear power. Contact R. A. Kampwirth, Edward Valves, Inc., 1200 W. 145th St., East Chicago, Indiana.

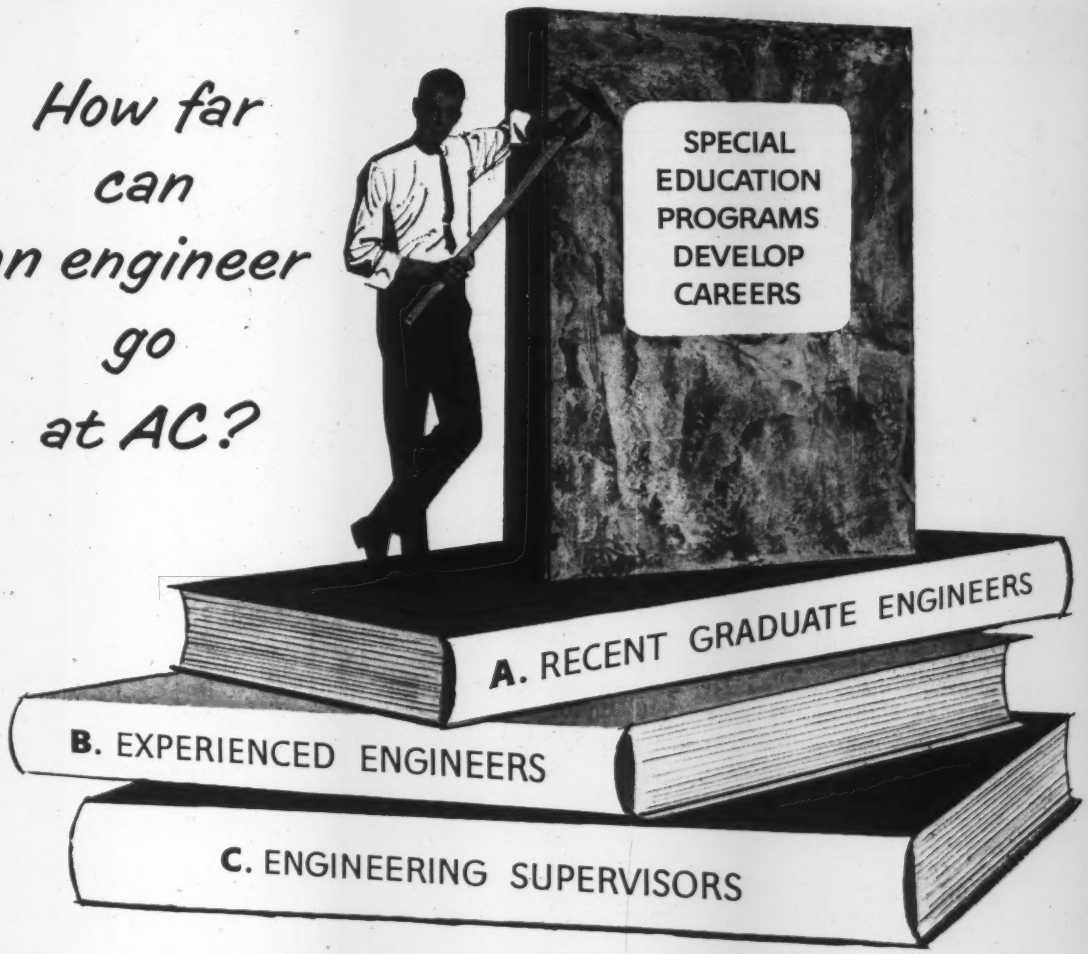
INSTRUMENTS and electronic pneumatic control systems for power and process industries. Contact G. S. Anderson, Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Illinois.

Subsidiaries of Rockwell Manufacturing Company

MAKE USE OF THE OPPORTUNITIES SECTION

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

How far can an engineer go at AC?



Finest "in house" programs anywhere

When you work in AC's instrumentation business, AC offers free comprehensive training programs that will help you grow professionally and enhance your status. Just look at these opportunities . . .

Program A—for recent graduate engineers—gives you a solid foundation in the theory and application of inertial guidance systems and servomechanisms. You attend classes three hours per day for four months, all on company time.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servomechanisms, environmental problems, engineering math and physics, plus advanced state-of-the-art courses. Time—during working hours or evenings.

Program C—for all engineering supervisors—involves management training developed by a team of AC executives and University of Chicago industrial relations experts. Sixty one-half-hour sessions give you a solid grounding in management techniques.

These thoroughly practical courses—taught by university professors or recognized AC specialists—constitute AC educational "extras." AC offers them in addition to their educational assistance programs for men who wish to study for degrees in nearby universities.

You may be eligible for training

If you are a graduate engineer in the electronics, electrical or mechanical fields, or if you have an advanced degree in mathematics or physics, you may be able to participate in these programs while you work on AC's famous AChiever inertial guidance system or a wide variety of other electromechanical, optical and infra-red devices.

For more details, just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. F, Box 746, South Milwaukee, Wisconsin.

Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers • Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes Speed Sensitive Switches • Speed Sensors • Torquemeters • Vibacall • Skyphone

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

ALCO PRODUCTS NEEDS

KEY PERSONNEL

FOR NUCLEAR POWER ENGINEERING DEPT.

REPORT DIRECTLY TO THE MANAGER

HEAD REACTOR ENGINEER

Supervises section responsible for reactor analysis, reactor experiments, thermal and hydraulics, mechanical core design, and mathematics.

Advanced Technical Degree required. Ph.D. desirable. Several years' experience in Nuclear Reactor Science and Engineering necessary, plus experience in technical administration.

CHIEF PROJECT ENGINEER

Administers and executes all projects in accordance with approved schedules and prepares and submits proposals.

Establishes and maintains effective controls and schedules on all projects.

Advanced degree desirable. Must have several years of direct line supervisory experience of engineering projects—preferably nuclear.

HEAD PLANT SYSTEMS ENGINEER

Supervises plant design engineering for the application of nuclear energy. Responsible for materials technology, including radio-chemistry and chemical engineering.

Advanced Technical Degree desirable. Several years of plant design experience necessary. Nuclear experience desirable.

Please send complete resume in confidence to: G. Y. Taylor, Administrative Services

ALCO PRODUCTS

INCORPORATED

Schenectady 5, New York

MECHANICAL ENGINEERS

For challenging positions in Mechanical Engineering Section of one of the leading processors of corn and soybeans. Positions involve mechanical and structural projects covering changes, improvements and additions to plant processes and buildings. Have openings ranging from beginning position for inexperienced B.S. graduate to position calling for 3 to 8 years' experience.

Growth and development opportunities with research minded company in expanding industry located in modern midwest city of 80,000.

For information send resume to G. M. Prust.

A. E. Staley Manufacturing Company, Decatur, Illinois.

Electrical Engineers.

Graduate; at least 5 years' experience design of industrial plant power and lighting systems.

Mechanical Engineer.

Graduate; at least 5 years' experience design of industrial, process and power plant layout and piping.

Piping Draftsmen.

Experienced design and detailing of industrial and process piping systems. 3 to 5 years' experience.

Unsurpassed company paid hospitalization, life insurance and retirement benefits. 40-hour week. New air conditioned offices, liberal salary. Permanent positions with excellent opportunities for advancement. Send complete resume of education and experience with salary requirements to:

PALMER AND BAKER ENGINEERS, INC.

P. O. Box 346 Mobile, Ala.

CONTROL ENGINEER
DESIGN ENGINEERS

We have an unusually interesting opening for a CONTROL SYSTEMS ENGINEER in our expanding development and engineering group, offering a unique opportunity to become acquainted with many operational phases of our integrated, multi-plant operations. This engineer will work with our various project groups on the specification and design of all types of controls for newly developed production equipment. He will have a title of PROJECT ENGINEER and will be given whatever drafting or engineering assistance that may be required. Age: 25–35 with B.S. or M.S degree. Willingness to travel between equipment manufacturers and our various plants is essential. Salary is open.

Immediate openings for DESIGN ENGINEERS in our expanding development engineering group to work on a variety of interesting problems covering many phases of our integrated multi-plant operations. If you have several years of machine design experience and would like to do design and development work on new automatic or semi-automatic paper converting machinery, then we have the right opening for you. Age: 25–30 with B.S. or M.S. degree.

Salary is open.

Send complete resume in confidence to:

Research Director

WEST VIRGINIA PULP

AND PAPER COMPANY

Covington, Virginia

ENGINEERS
positions of
UNIQUE RESPONSIBILITY
on
MISSILE CONTROL SYSTEMS

Opportunity for engineers with 2 or more years professional experience in the mechanical, marine, electrical or electronics fields to take complete charge of static and operational tests of equipment and systems in Polaris missile fire control and navigation, missile launching and handling, nuclear reactor control and instrumentation, electric power generation and distribution, high-pressure air and hydraulic service systems and many other equally challenging submarine systems.

General Dynamics' Electric Boat Division, best known as the birthplace of the nuclear powered submarine, is active in many diverse R&D areas, including large control systems for a precise radio telescope and the world's largest wind tunnel, as well as simulators and training devices for missiles, submarines and other weapons systems.

These positions afford a high degree of responsibility and the opportunity to broaden in technical experience. If you are interested, please write details of your background and experience to James P. O'Brien, Technical Employment Supervisor.

GENERAL DYNAMICS
ELECTRIC BOAT DIVISION
GROTON, CONNECTICUT

POSITIONS OPEN

WANTED
ELECTRICAL ENGINEER

Design Engineer for automatic control and general design work. Board work involved. Excellent opportunity in large central engineering office. Give experience and salary range with application. Location South.

Address CA-6729, care of "Mechanical Engineering."

SALES ENGINEERS WANTED

for New York, St. Louis, Cleveland, Detroit, Baltimore, San Francisco, and El Paso, Texas. Prefer graduate Chemical, Electrical, or Mechanical Engineers with two or three years' industrial experience. Trainees will receive intensive training course with daily classroom instruction at Waterbury factory before assignment to district office. Mail reply to

H. E. Beane, Vice President
THE BRISTOL COMPANY
Waterbury 20, Connecticut

GENERAL MAINTENANCE SUPERINTENDENT

A nationally-known industrial chemical producer has an opening for a qualified mechanical engineer as plant maintenance superintendent in one of its major plants.

Position responsibilities involve administration of the overall maintenance program in a multi-unit chemical process plant.

Applicants should have 10–15 years' previous experience in plant maintenance and engineering with recent experience in maintenance supervision.

Please submit a resume of background and experience to Professional Employment Manager.

U.S. Industrial Chemicals Co.
Div. of National Distillers & Chemical Corp.
99 Park Ave., New York 16, N. Y.

ENGINEERING FACULTY being expanded in E. E., M. E., and I. E., departments in vigorous institution. Positions at various levels, depending upon education and experience; M. S. or higher degree desired. Now offering graduate programs also, in M. E. and I. E. Prefer interests as follows: in E. E., circuit theory, electrical machinery, and electronics; in M. E., aerodynamics and fluid mechanics, with 2/3 teaching, 1/3 research; in I. E., manufacturing engineering, control systems, and metallurgy. Send full background to Dean, College of Engineering, University of Bridgeport, Park Avenue, Bridgeport 4, Connecticut.

MECHANICAL ENGINEER. We need a man with a lot of drive who can design machinery, then follow it through the shop and make the installation in the customer's plant if necessary. We design and manufacture special machinery—mostly ceramic machinery, and our business is nationwide. We are in Western New York State, near metropolitan and vacation areas. The education and recreational facilities are excellent. Contact Personnel Manager, A. J. Wahl, Inc., Brocton, New York.

The United States Army Transportation Supply & Maintenance Command, 12th and Spruce Streets, St. Louis, Mo. has vancancies for ENGINEERING POSITIONS: Aeronautical Development Engineer, Aeronautical Engineer, Mechanical Engineer, Electronic Engineer, Aeronautical Power Plant Engineer, Materials Engineer, and General Engineer. The salaries for these positions range from $5,430 to $11,355 per annum. The minimum age limit is 18 with no maximum. In addition to a college degree 1, 2, or 3 years' experience in one of the above fields is necessary. Apply by contacting the Civilian Personnel Office at the above address.

TWO TEACHERS, Department of Mechanics and Electricity. One, department head, Ph. D. mechanical engineering preferred. Degree in physics for second position. B.S. or M.S. also considered. Teach mechanics, strength of materials, thermodynamics, applied electricity, general physics. Salary and rank dependent on qualifications. Apply President, Montana School of Mines, Butte, Montana.

ASSISTANT PROFESSOR—Faculty position available for September 1959. Ph.D. degree required. Work is of both advanced undergraduate and graduate level in aerodynamics. Opportunity for research. Salary dependent upon training and experience. Apply to Head, Department of Aeronautical Engineering, University of Cincinnati, Cincinnati 21, Ohio.

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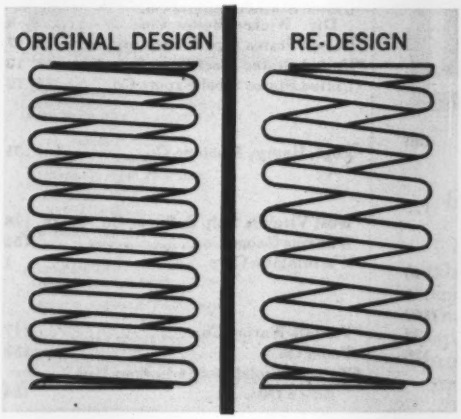

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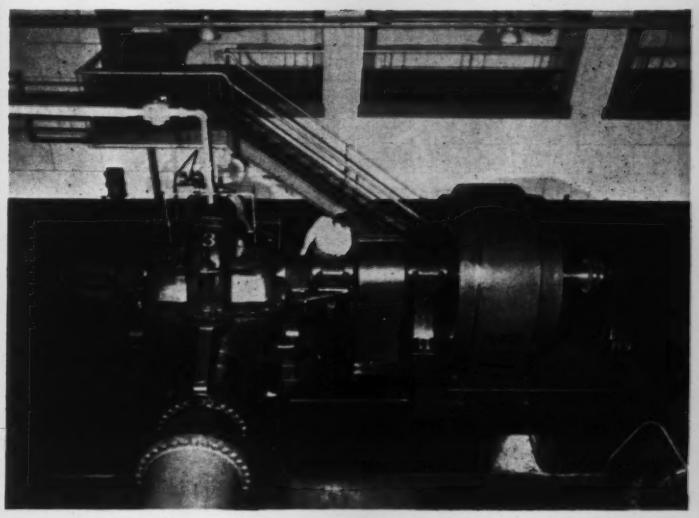

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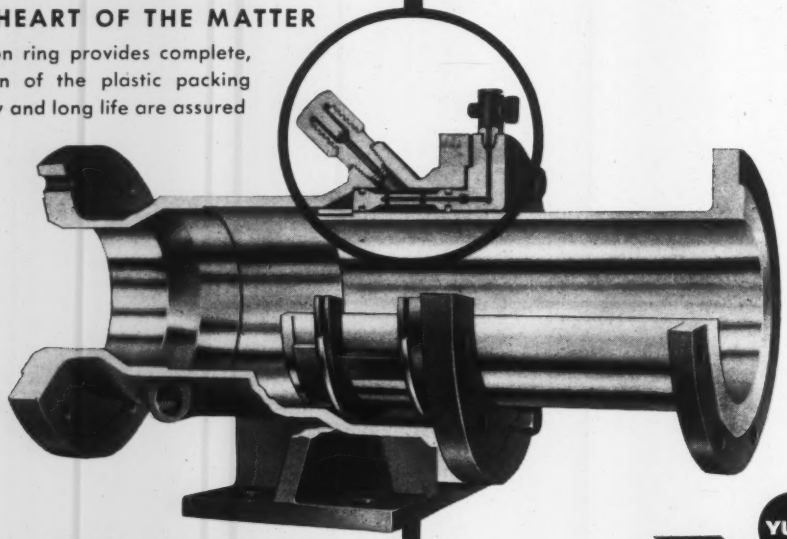

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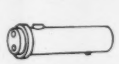

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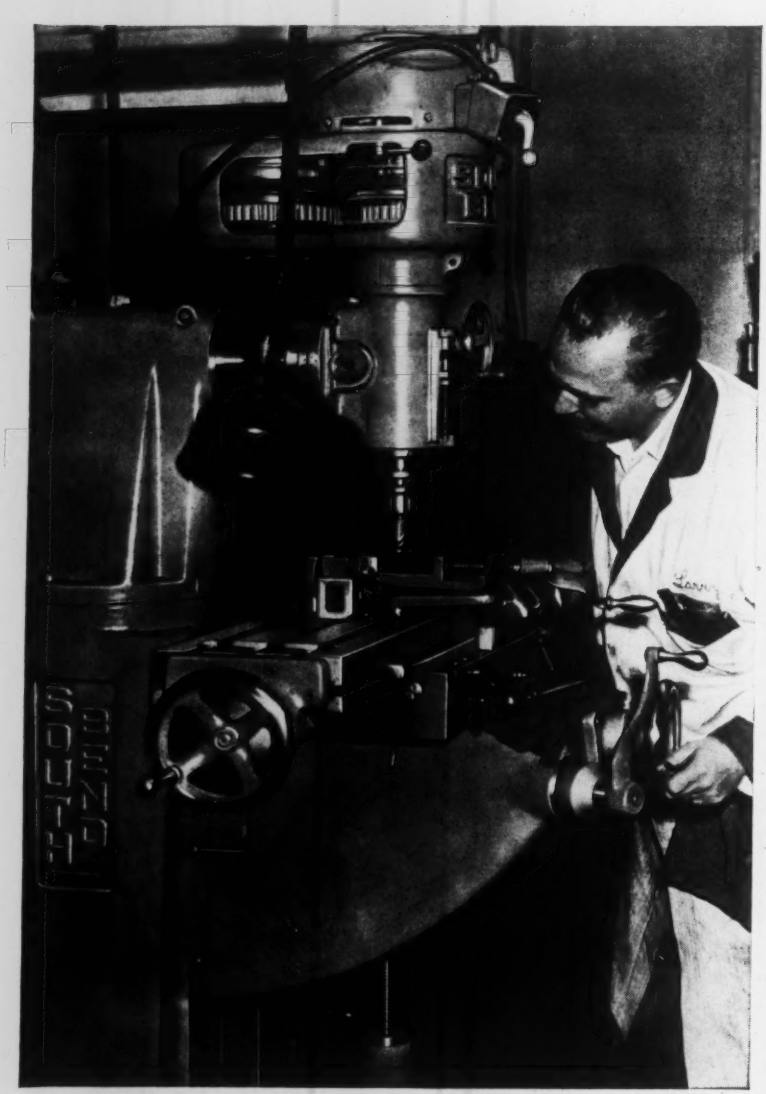

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